

PM008 – 05 December 2023

Update on PINNs

Application to Urban Wind Field Dispersion Studies

Script Version v4

- 1) PINN is now completely customizable – customizable input and output parameters, batch normalization, dropout rate, neuron number, number of hidden layers – all options in the config file (PM007)
- 2) Saving of all the losses (not just the total loss) (PM007)
- 3) Plotting of loss vs epochs now automatic (PM007)
- 4) Boundary conditions – relaxed no slip condition included (PM007)
- 5) New angles included (PM007)
- 6) Smaller batch sizes (I disagree) – customizable from config file (PM007)
- 7) Testing and Predicting Loss during training phase (PM008)
- 8) Inlet Boundary Conditions added (PM008)
- 9) Script is modified for TPU use, testing underway (PM008)

Scripts v4 – Preliminary Results

Some Parameters

Infinite epochs - instead the criteria for stopping is $\text{loss}_{\{n\}} - \text{loss}_{\{n-1\}} < \epsilon$ for 10 consecutive epochs where n is the epoch number and $\epsilon = 1E-5$ (user defined)

128 Neurons for the PINN unless otherwise specified

We have the data for 13 angles, [0, 15, 30, 45, 60, 75, 90, 105, 120, 135, 150, 165, 180] in degrees

We concatenate the data for angles = [0, 15, 30, 45, 60, 75, 90, 105, 120, 135, 150, 165, 180] and then take 99% of the dataset with random seed = 42 for training and 1% for testing

By using 99% of the whole dataset we hope to make the NN learn about wind angle such that the parameters become functions of the wind angle

Then using the trained neural network we predict the data for angle = 135

For this run, we will only have input parameters to be [X, Y, Z, $\cos(\theta)$, $\sin(\theta)$] and the output parameters will be [U, V, W]

Progress so far - Data Loss Only
Standard Normal Scalar
(Adam Optimizer)

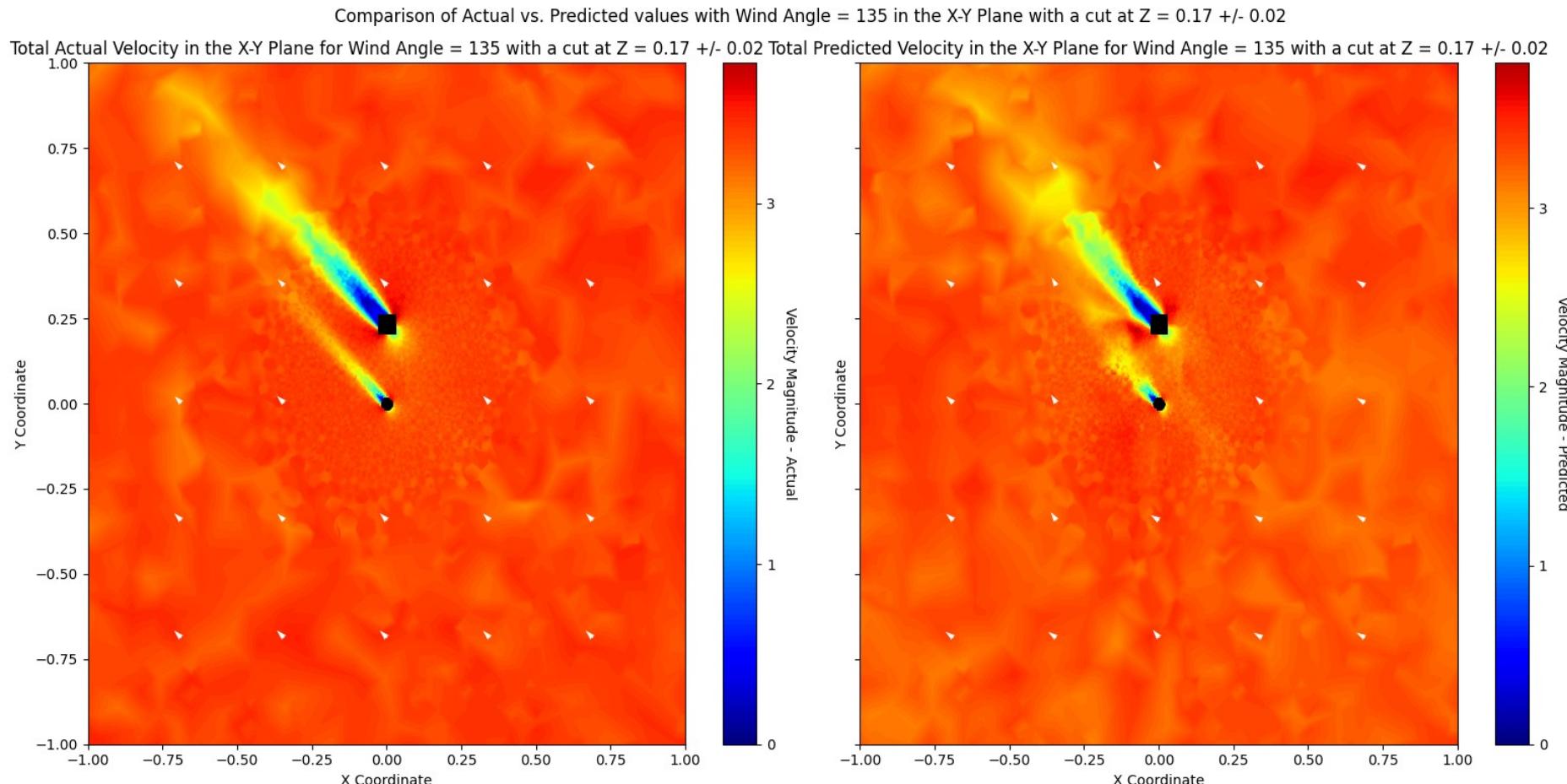
Threshold = 1E-5 (14505 Epochs, not completed), GPU Laptop

Scripts v4 – PREDICTING (135 DEG)

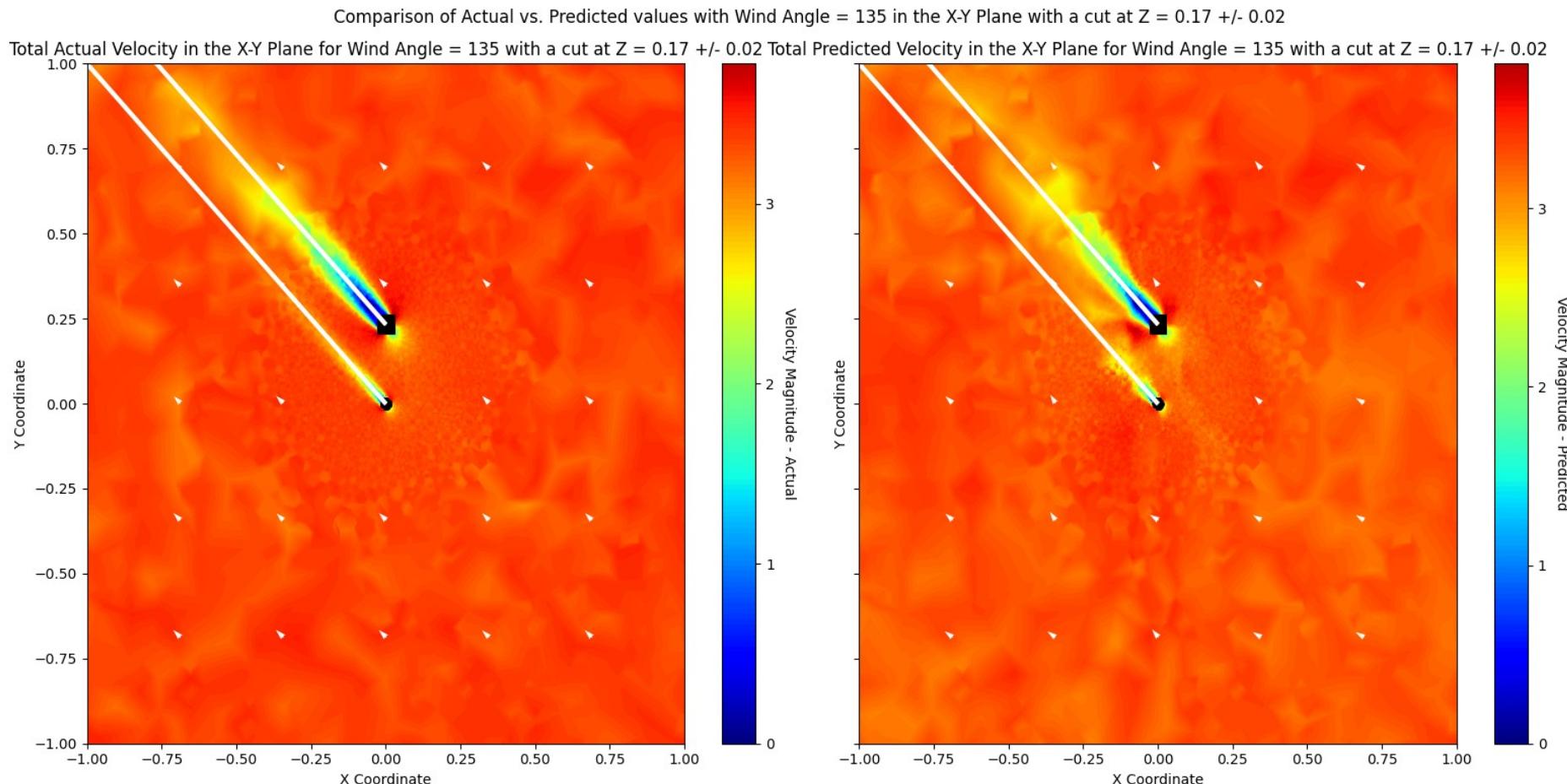
Progress so far - Data Loss Only (Adam Optimizer – Std Normal Scalar)
Threshold = 1E-5 (14505 Epochs, so far...), GPU Laptop
Predicting Results – Metrics (Angle = 135)

Variable	MSE	RMSE	MAE	R2
Velocity:0	0.250057728211143	0.500057724878981	0.413546267613177	0.754659487654433
Velocity:1	0.247255388675443	0.497247814148482	0.412825970825431	0.759721760865162
Velocity:2	0.0014839236719385	0.0385217298669016	0.0149620490506694	0.954639574806382

Progress so far - Data Loss Only (Adam Optimizer – Std Normal Scalar), Threshold = 1E-5 (14505 Epochs, so far...), GPU Laptop
Predicting Results - X-Y Total Velocity Plot (Angle = 135)



Progress so far - Data Loss Only (Adam Optimizer – Std Normal Scalar), Threshold = 1E-5 (14505 Epochs, so far...), GPU Laptop
Predicting Results - X-Y Total Velocity Plot (Angle = 135)

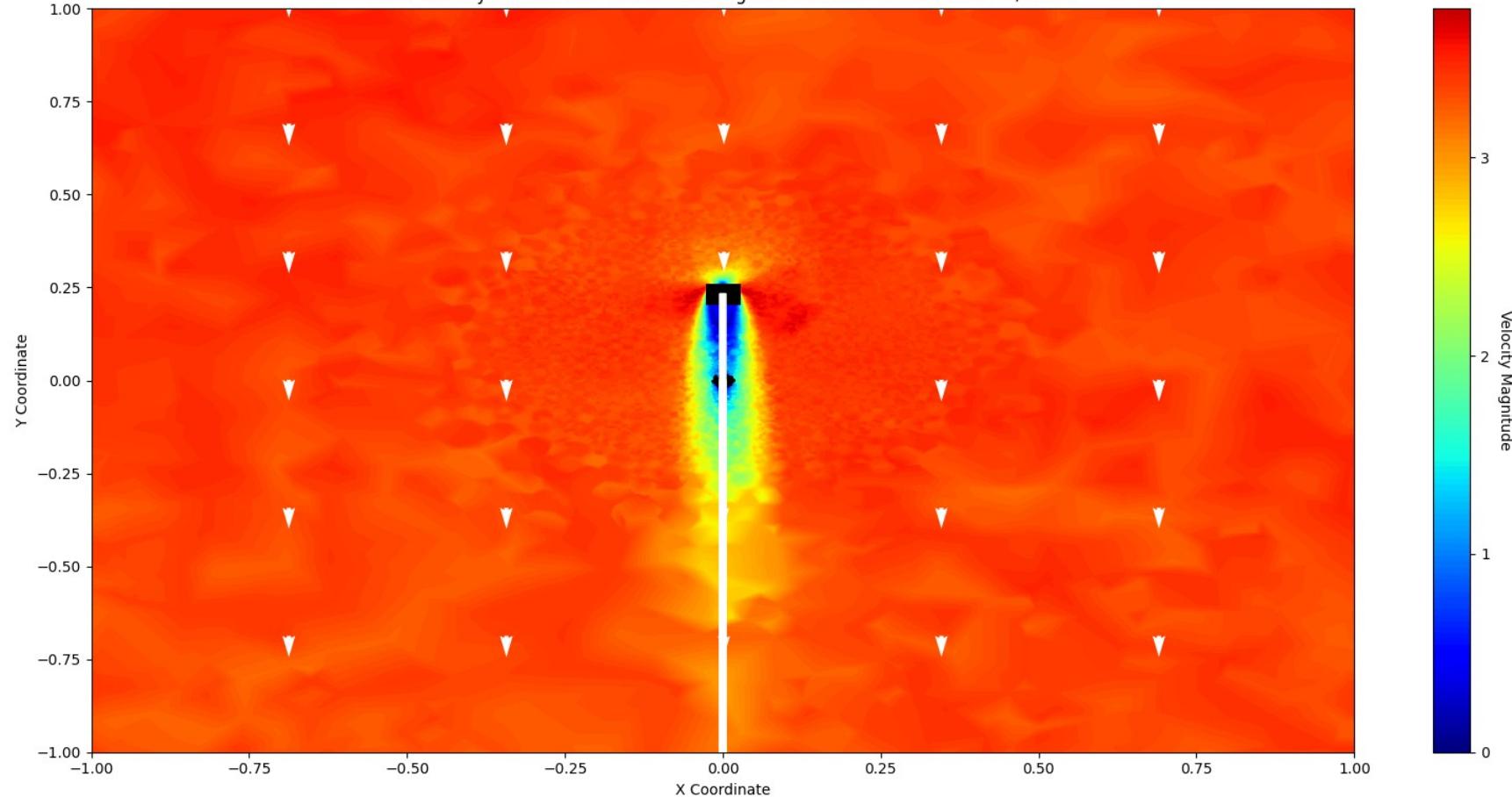


Progress so far - Data Loss Only
Standard Normal Scalar
(Adam Optimizer)

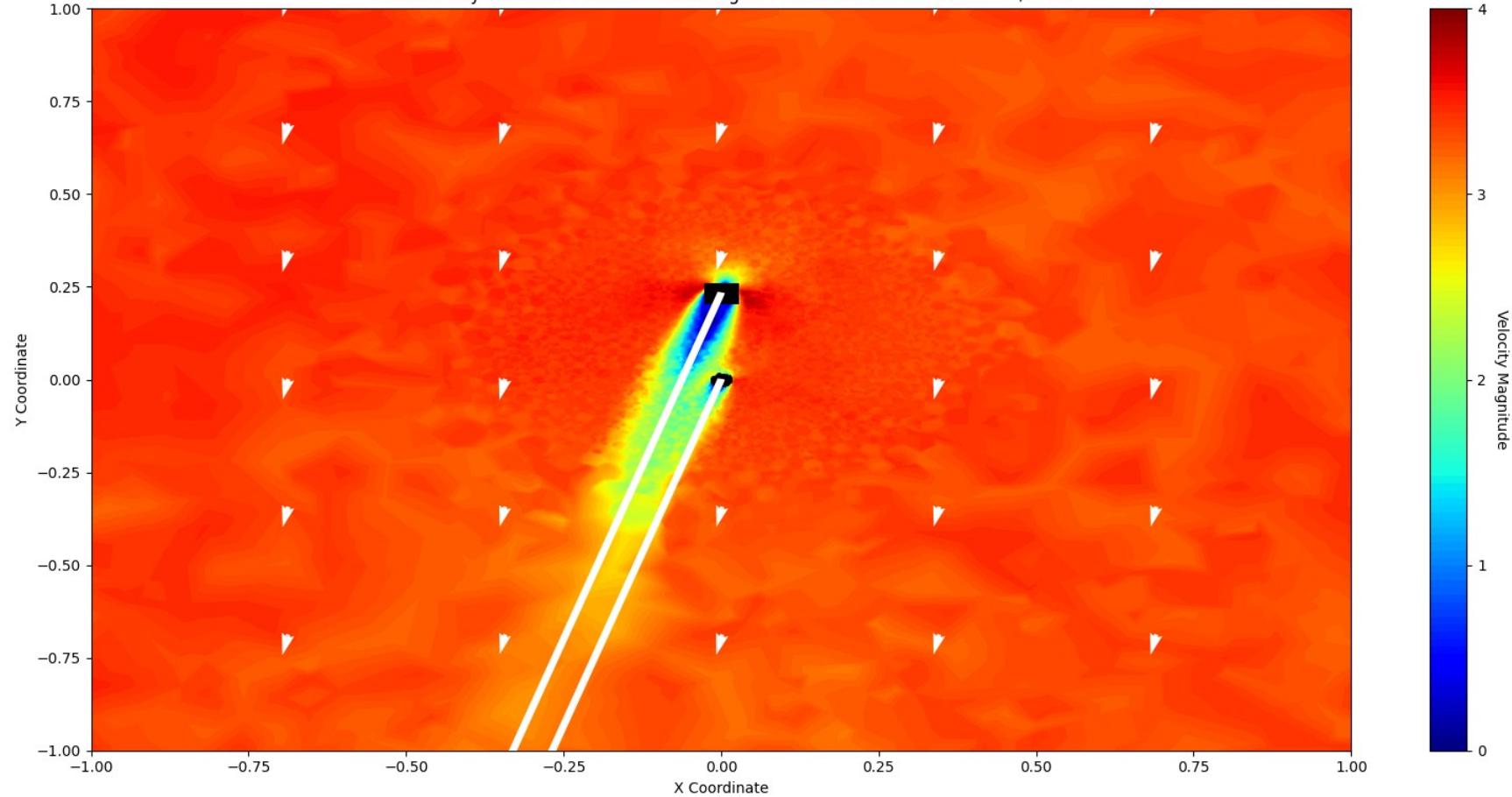
Threshold = 1E-5 (14505 Epochs, not completed), GPU Laptop

Scripts v4 – Plotting Any Angle

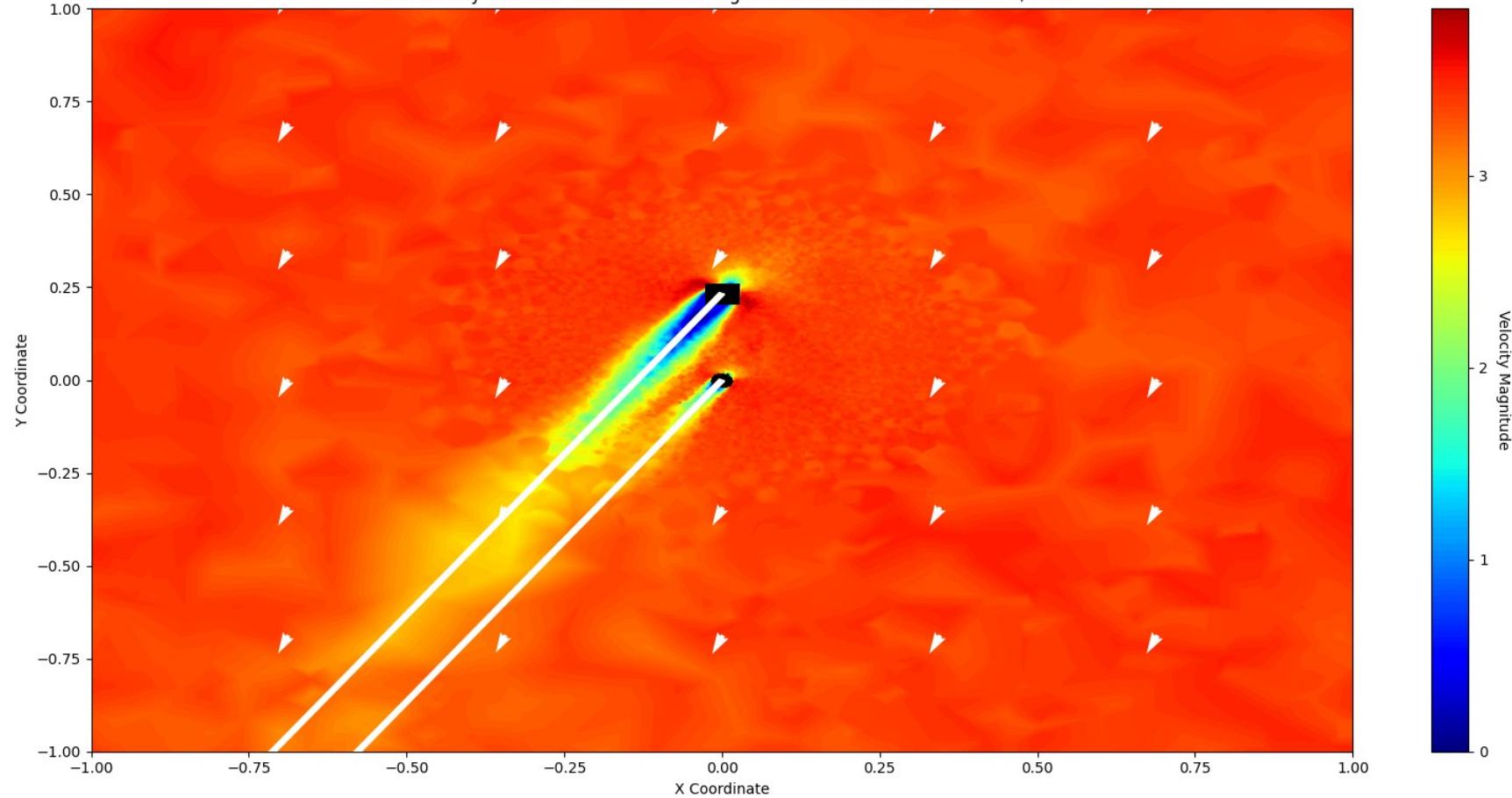
Total Velocity in the X-Y Plane for Wind Angle = 0 with a cut at Z = 0.17 +/- 0.02



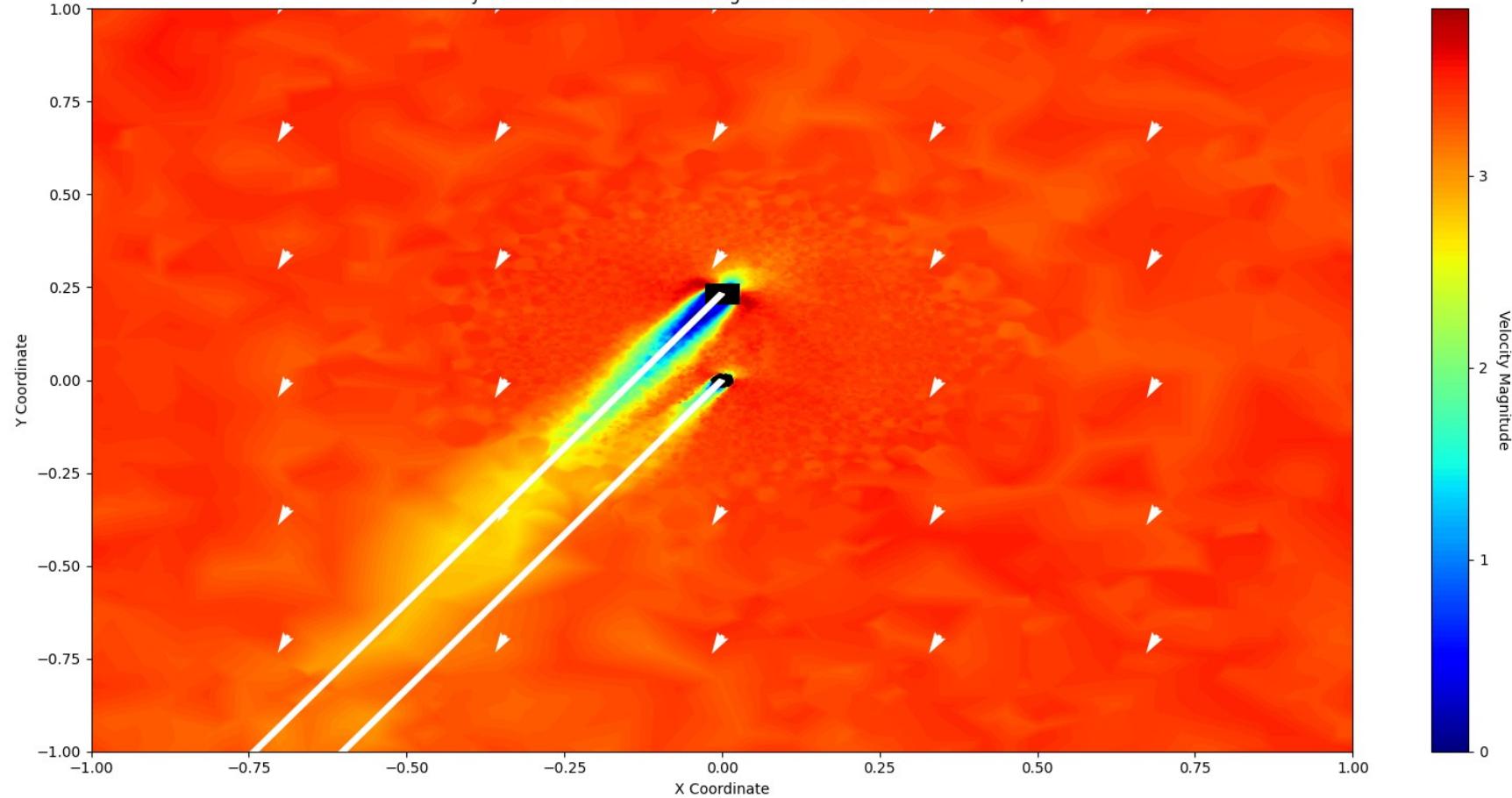
Total Velocity in the X-Y Plane for Wind Angle = 15 with a cut at Z = 0.17 +/- 0.02



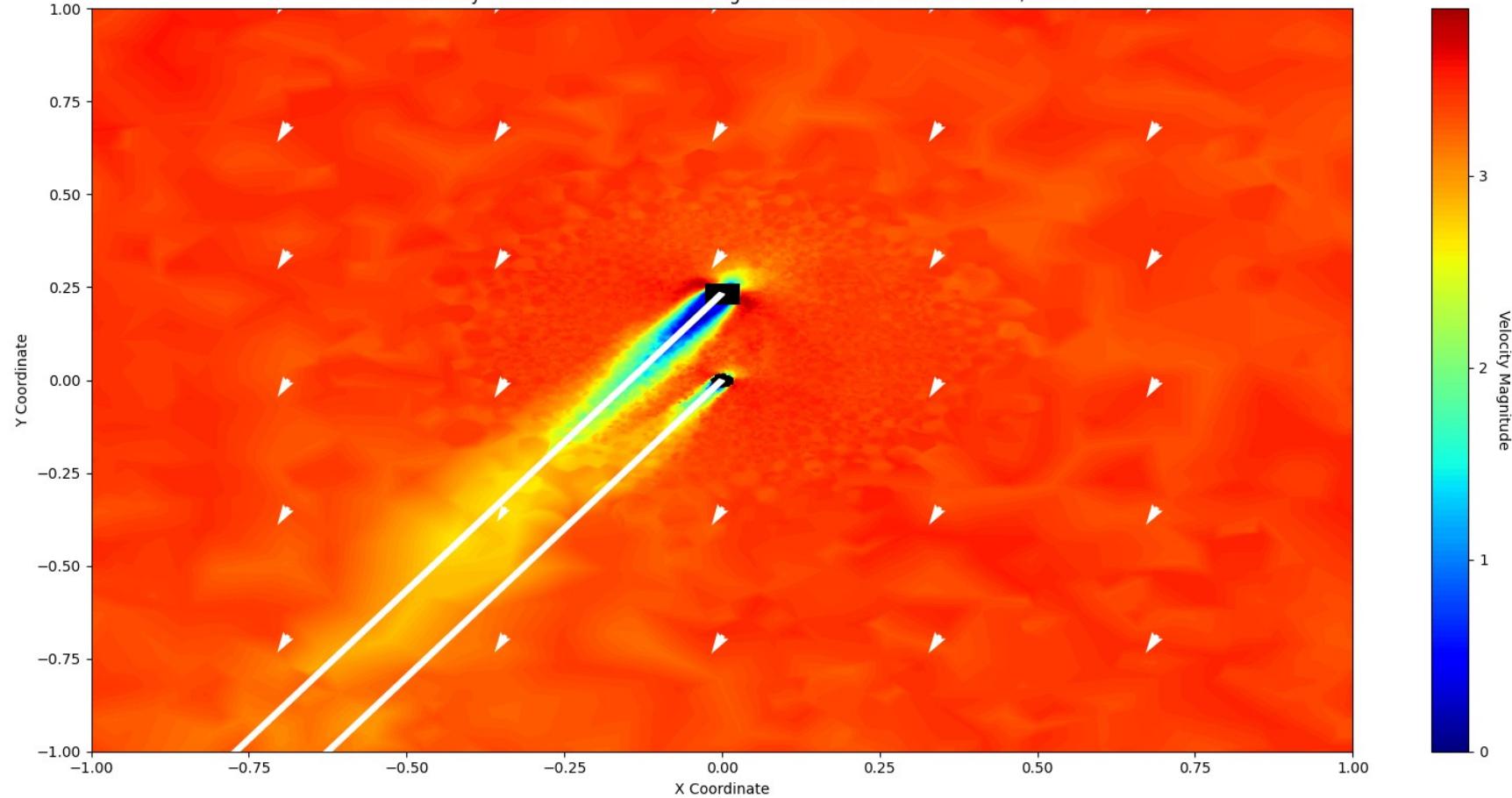
Total Velocity in the X-Y Plane for Wind Angle = 30 with a cut at Z = 0.17 +/- 0.02



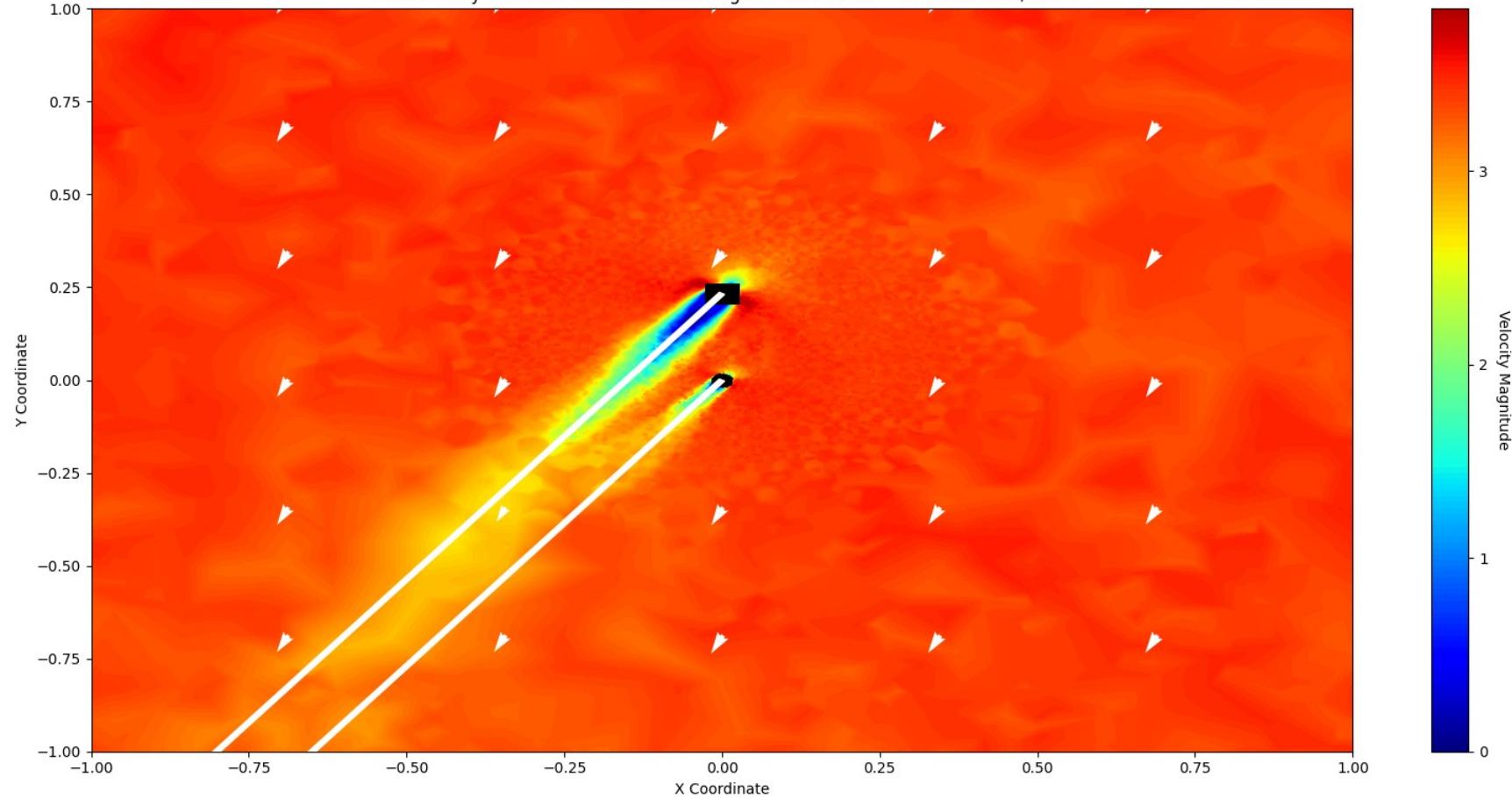
Total Velocity in the X-Y Plane for Wind Angle = 31 with a cut at Z = 0.17 +/- 0.02



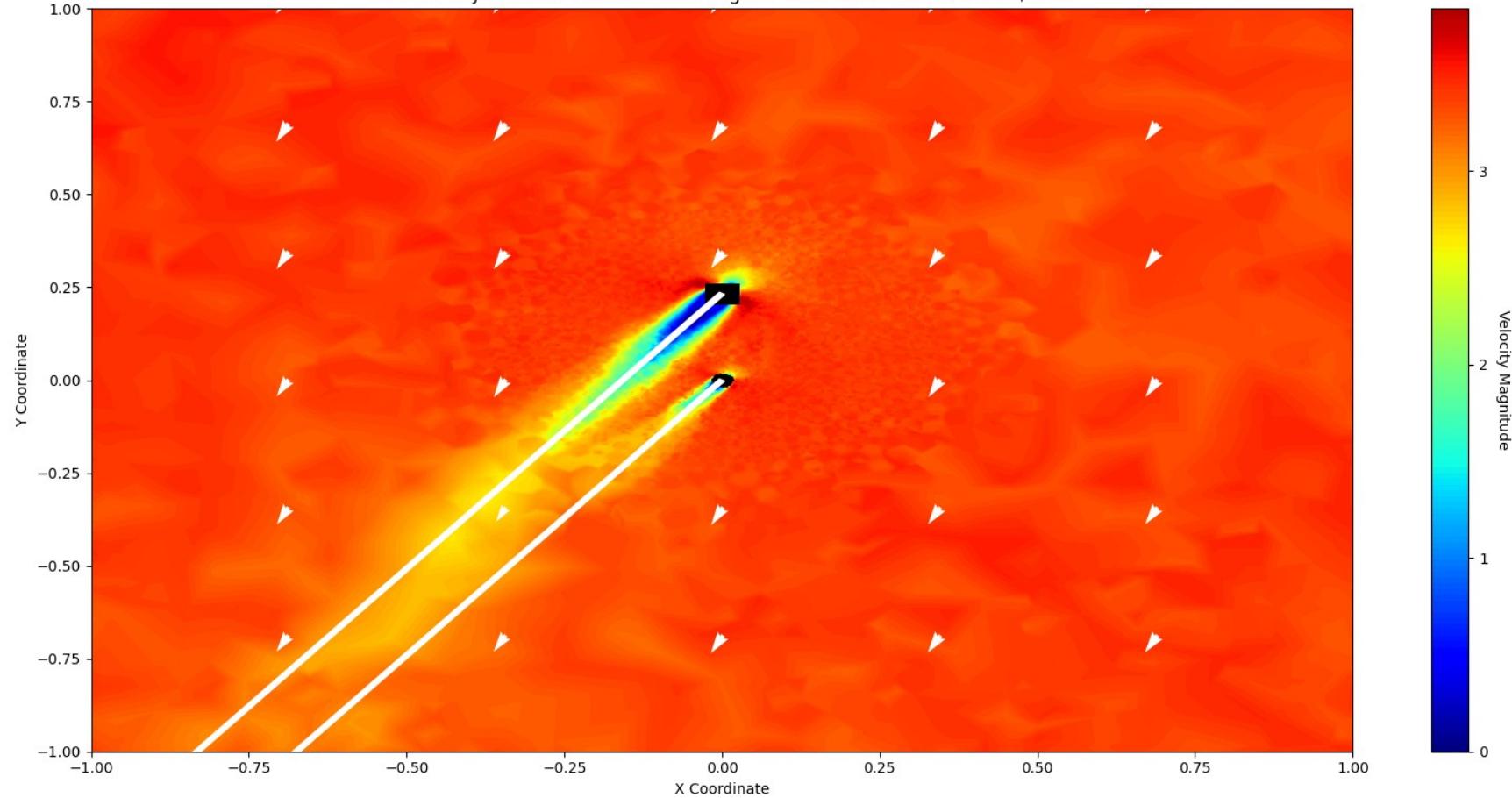
Total Velocity in the X-Y Plane for Wind Angle = 32 with a cut at Z = 0.17 +/- 0.02



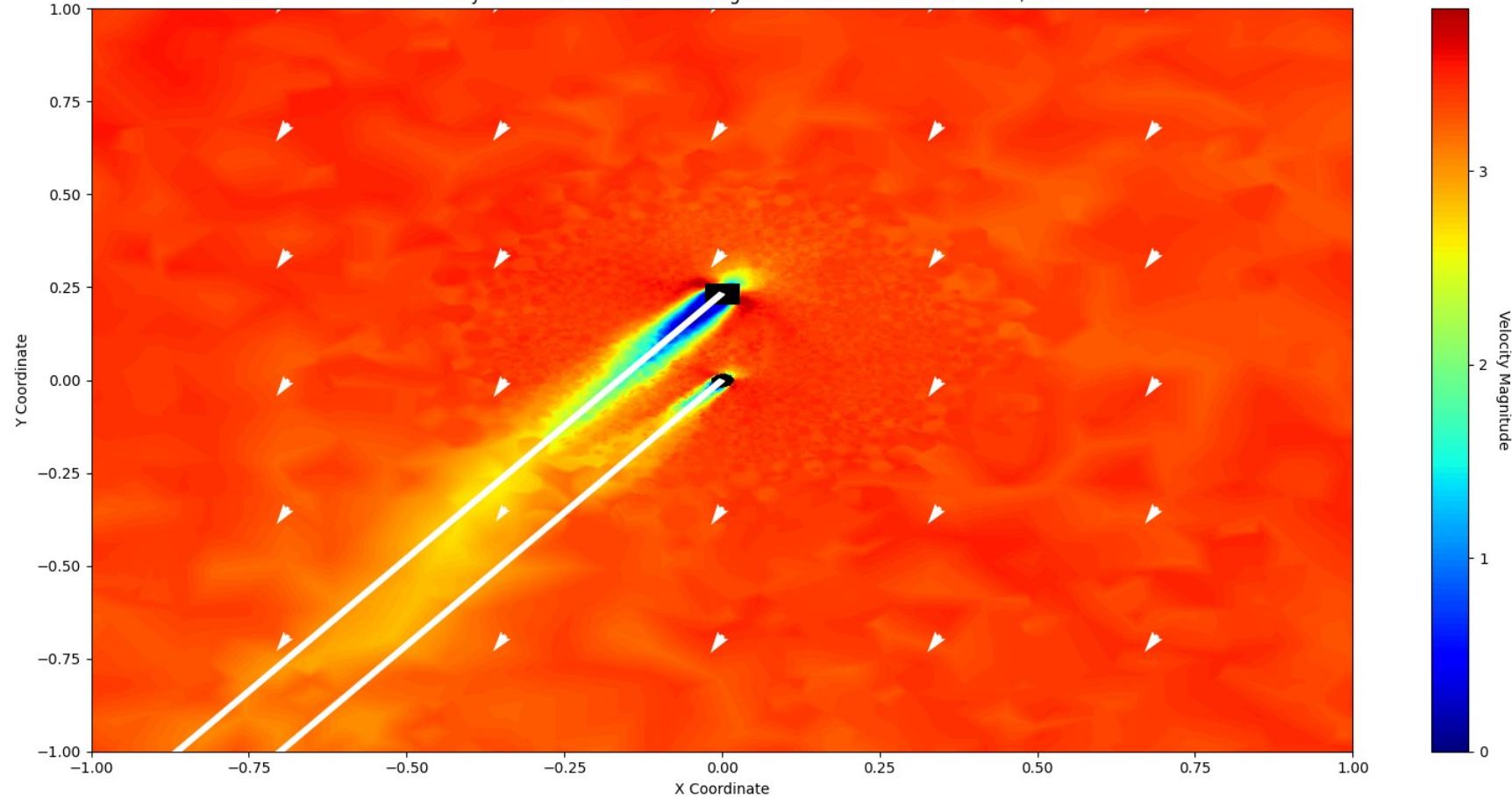
Total Velocity in the X-Y Plane for Wind Angle = 33 with a cut at Z = 0.17 +/- 0.02



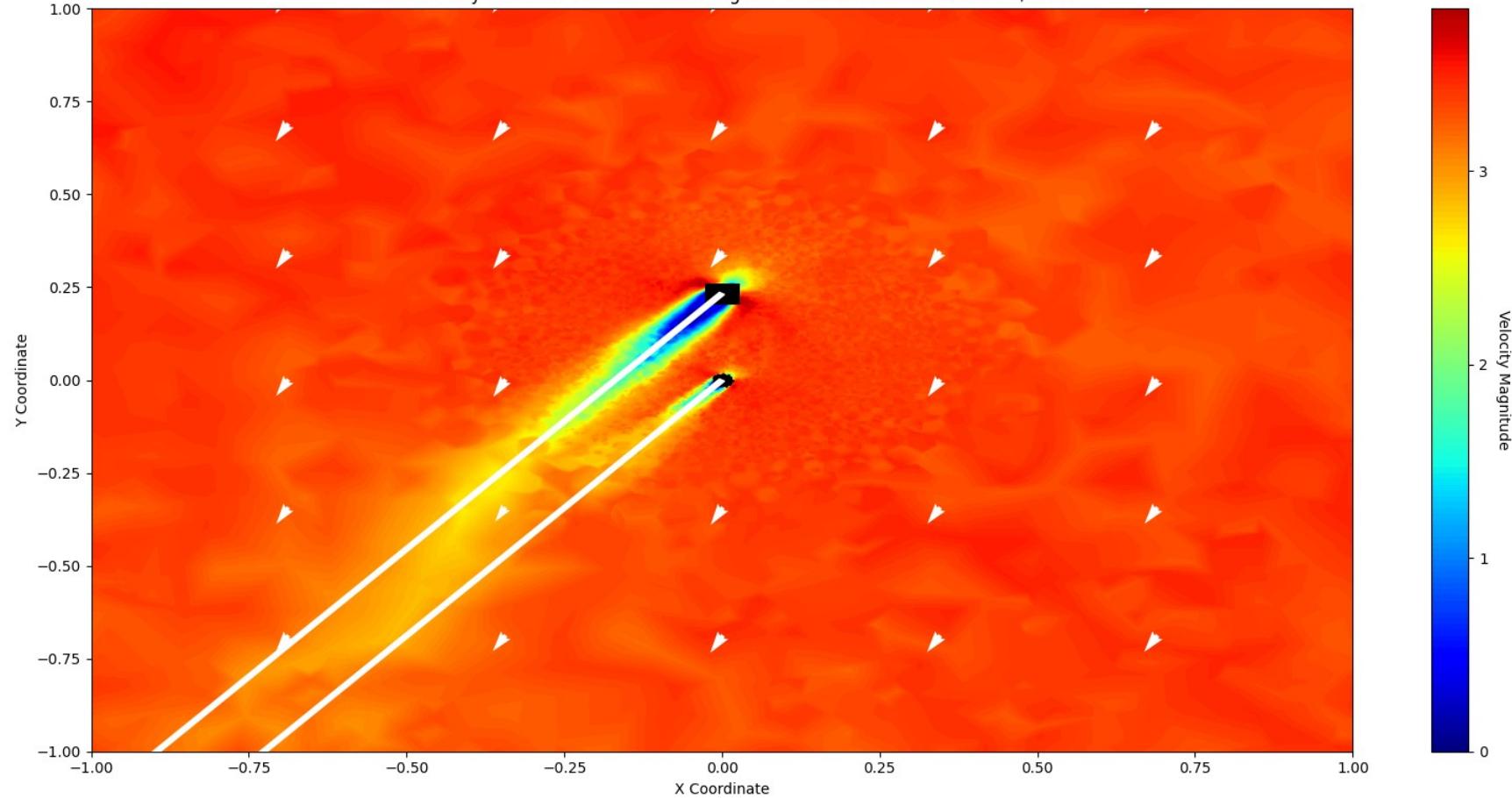
Total Velocity in the X-Y Plane for Wind Angle = 34 with a cut at Z = 0.17 +/- 0.02



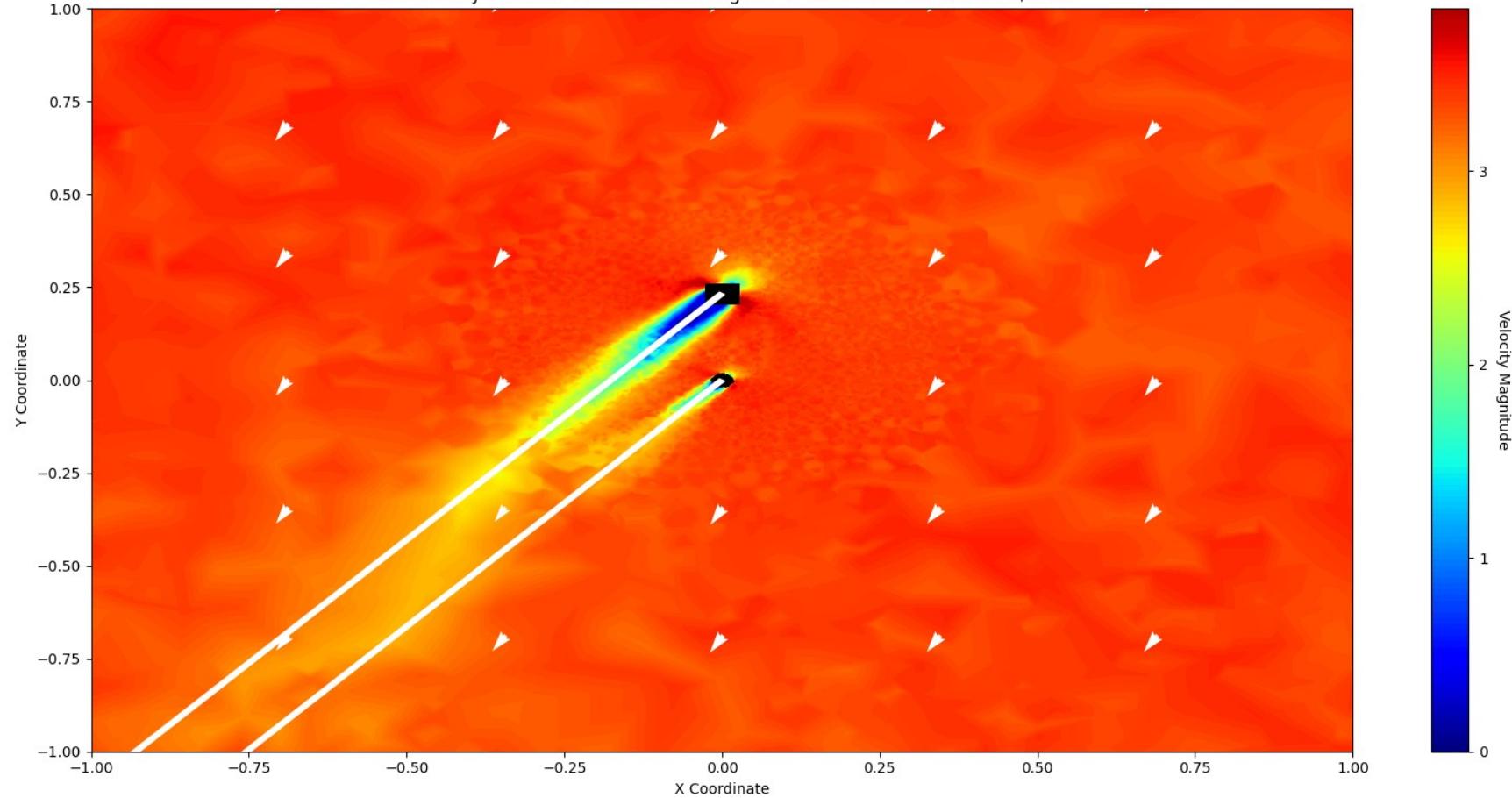
Total Velocity in the X-Y Plane for Wind Angle = 35 with a cut at Z = 0.17 +/- 0.02



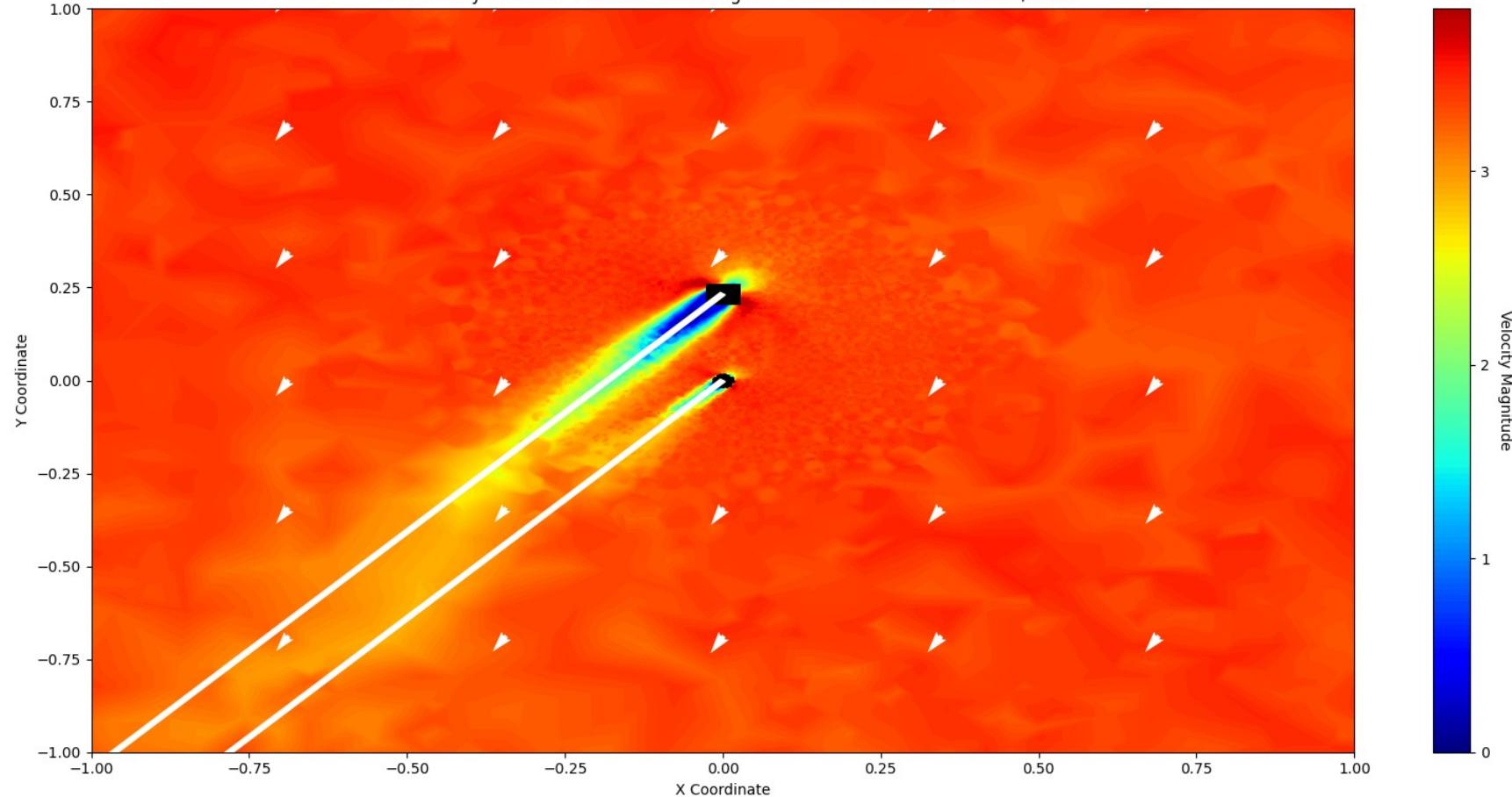
Total Velocity in the X-Y Plane for Wind Angle = 36 with a cut at Z = 0.17 +/- 0.02



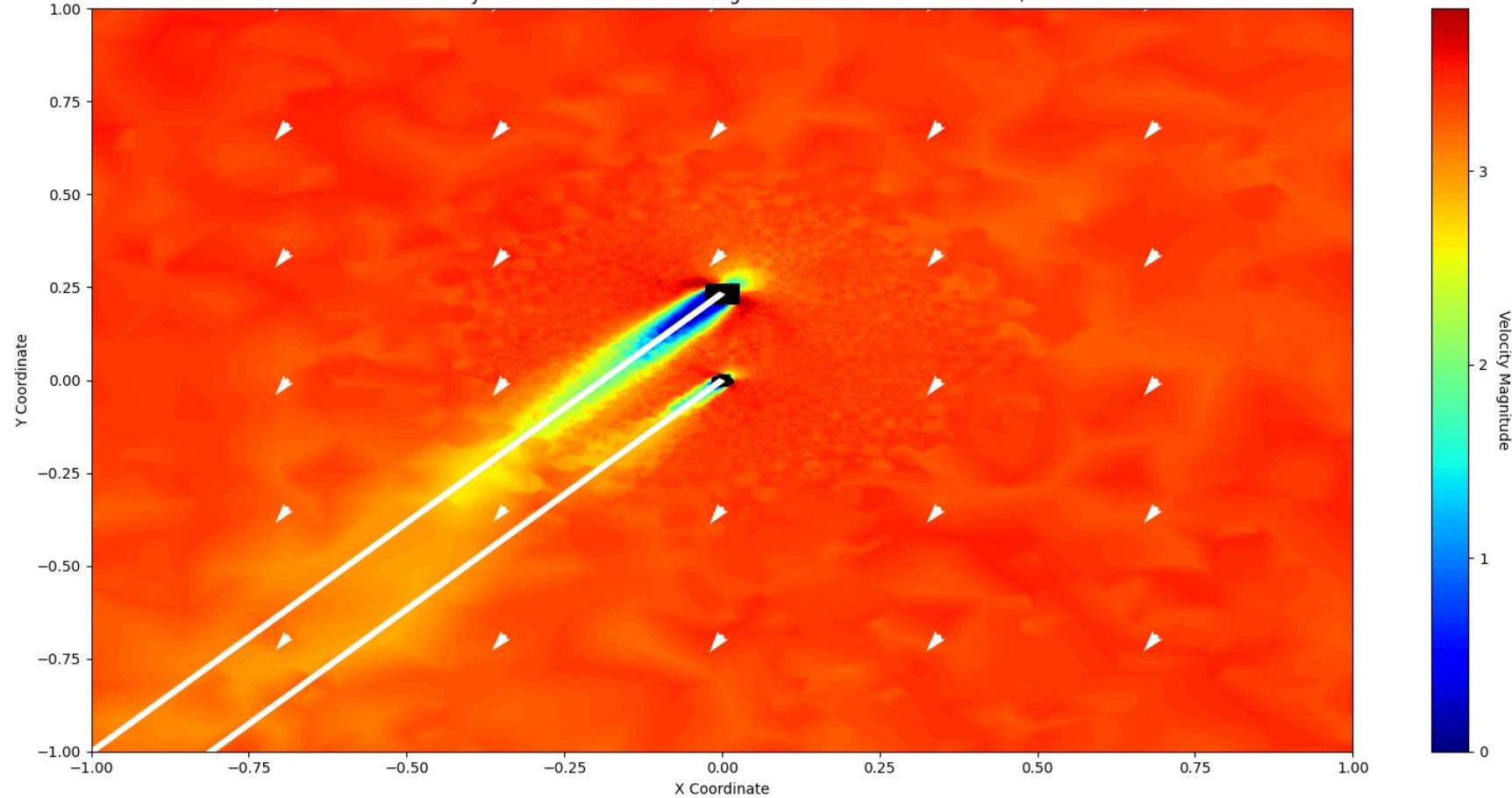
Total Velocity in the X-Y Plane for Wind Angle = 37 with a cut at Z = 0.17 +/- 0.02



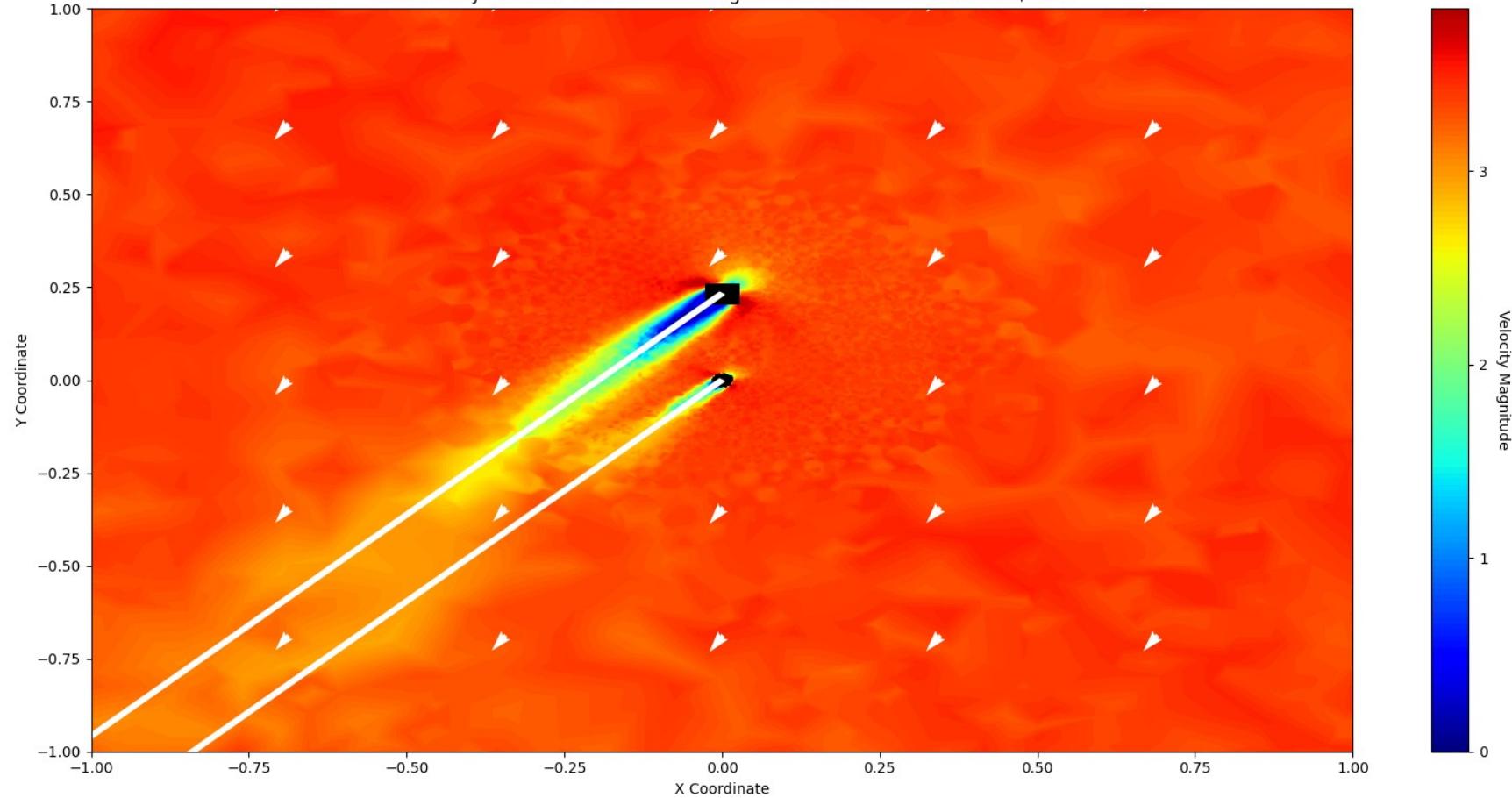
Total Velocity in the X-Y Plane for Wind Angle = 38 with a cut at Z = 0.17 +/- 0.02



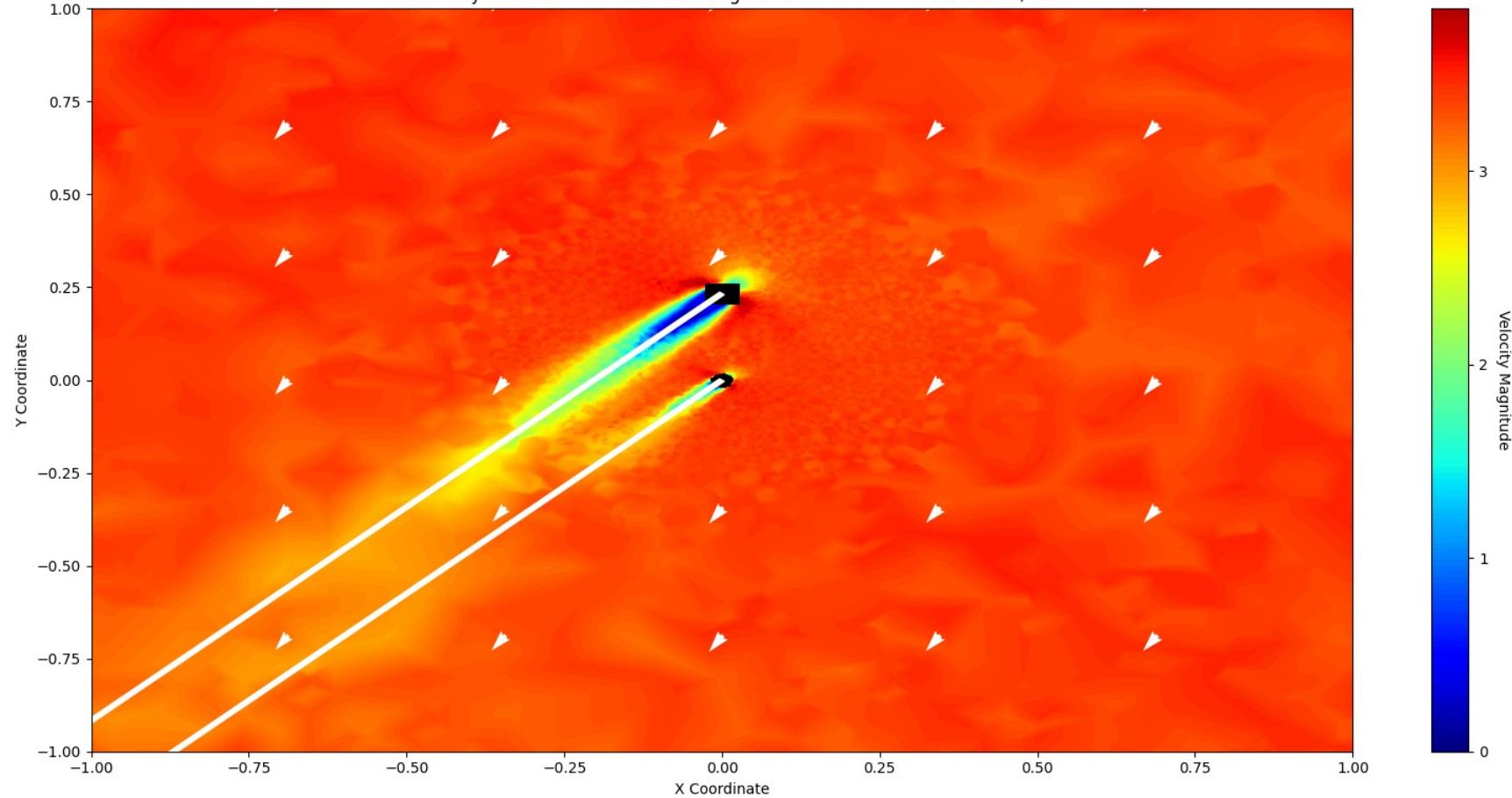
Total Velocity in the X-Y Plane for Wind Angle = 39 with a cut at Z = 0.17 +/- 0.02



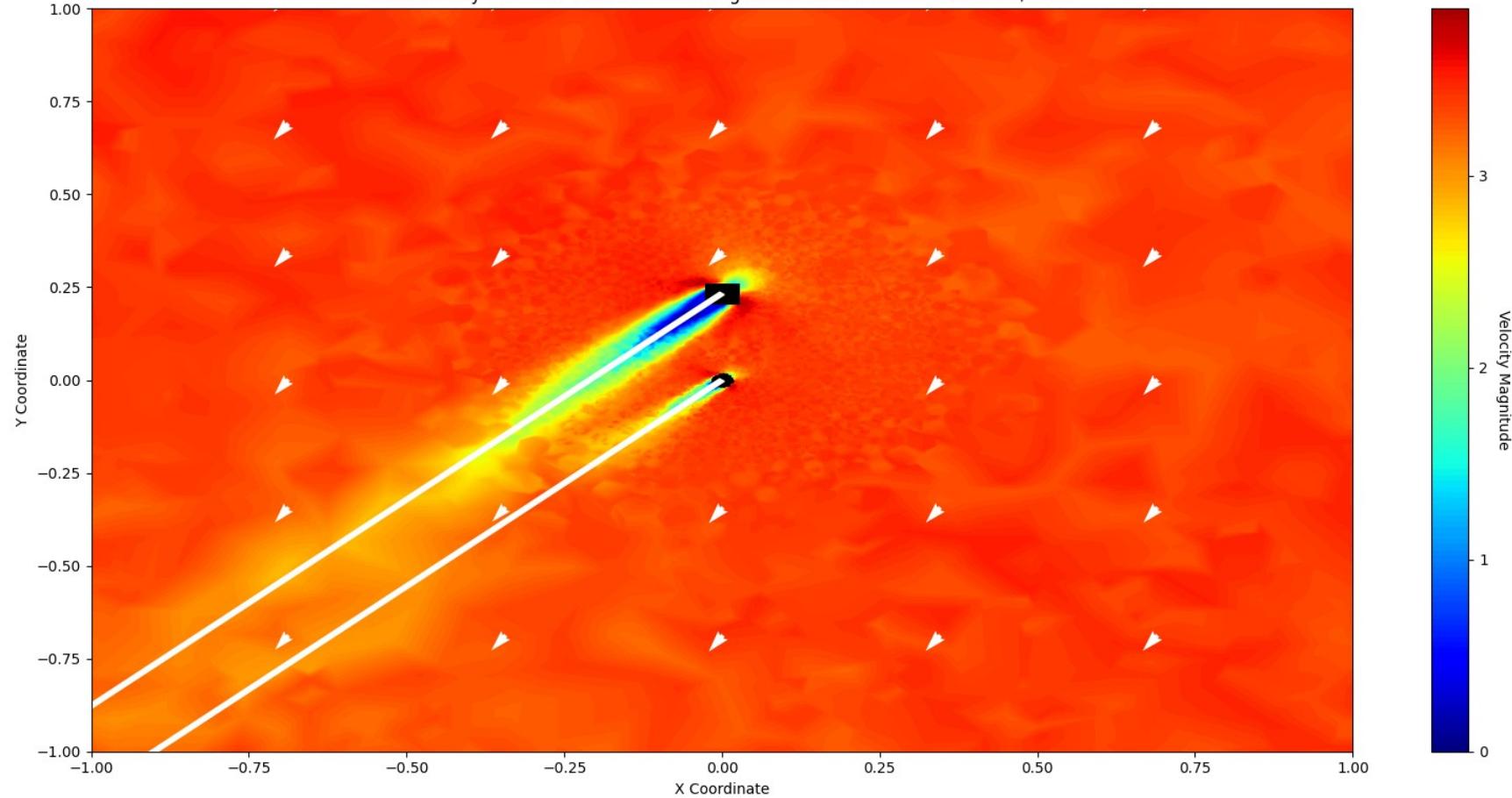
Total Velocity in the X-Y Plane for Wind Angle = 40 with a cut at Z = 0.17 +/- 0.02



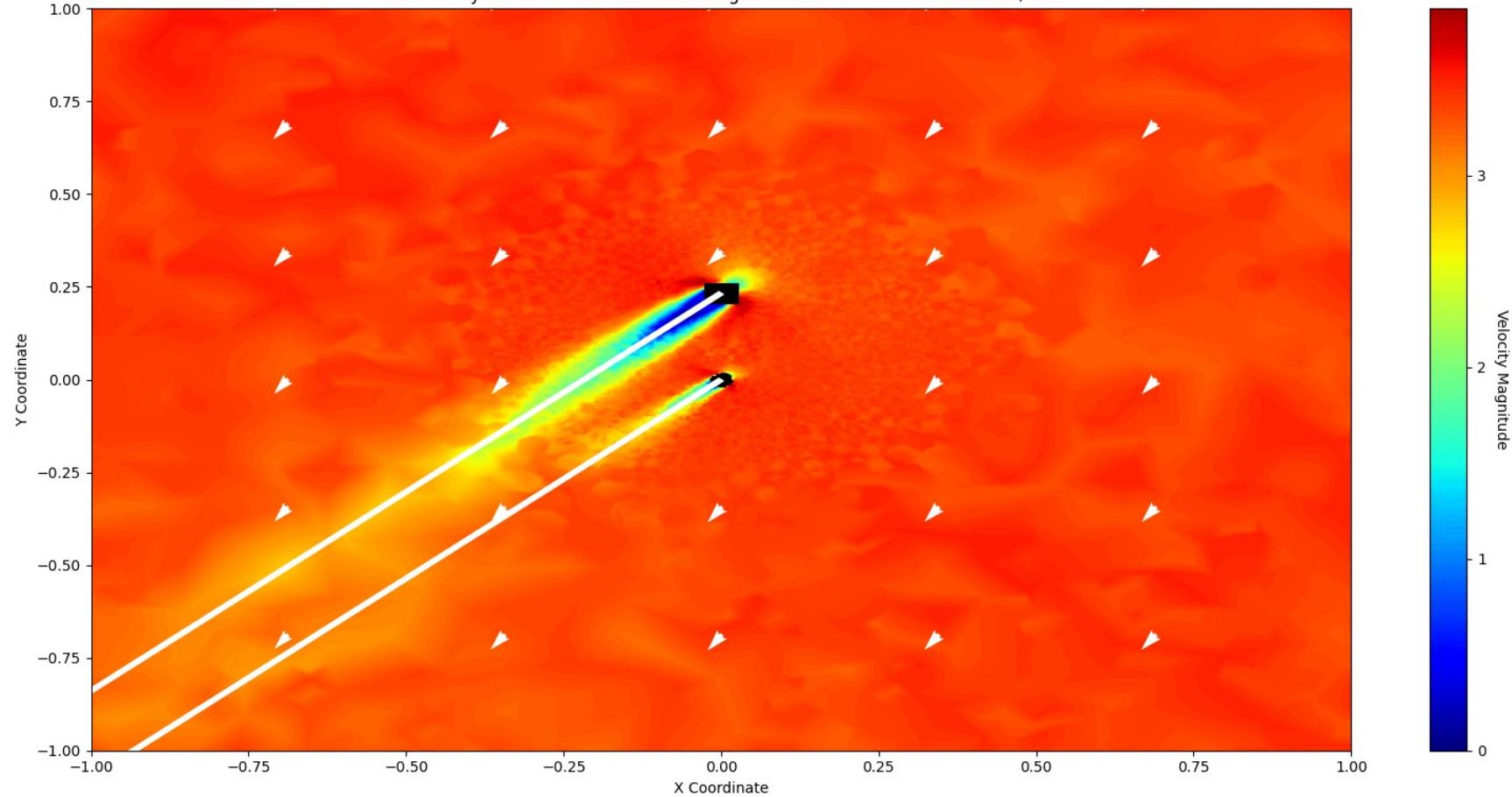
Total Velocity in the X-Y Plane for Wind Angle = 41 with a cut at Z = 0.17 +/- 0.02



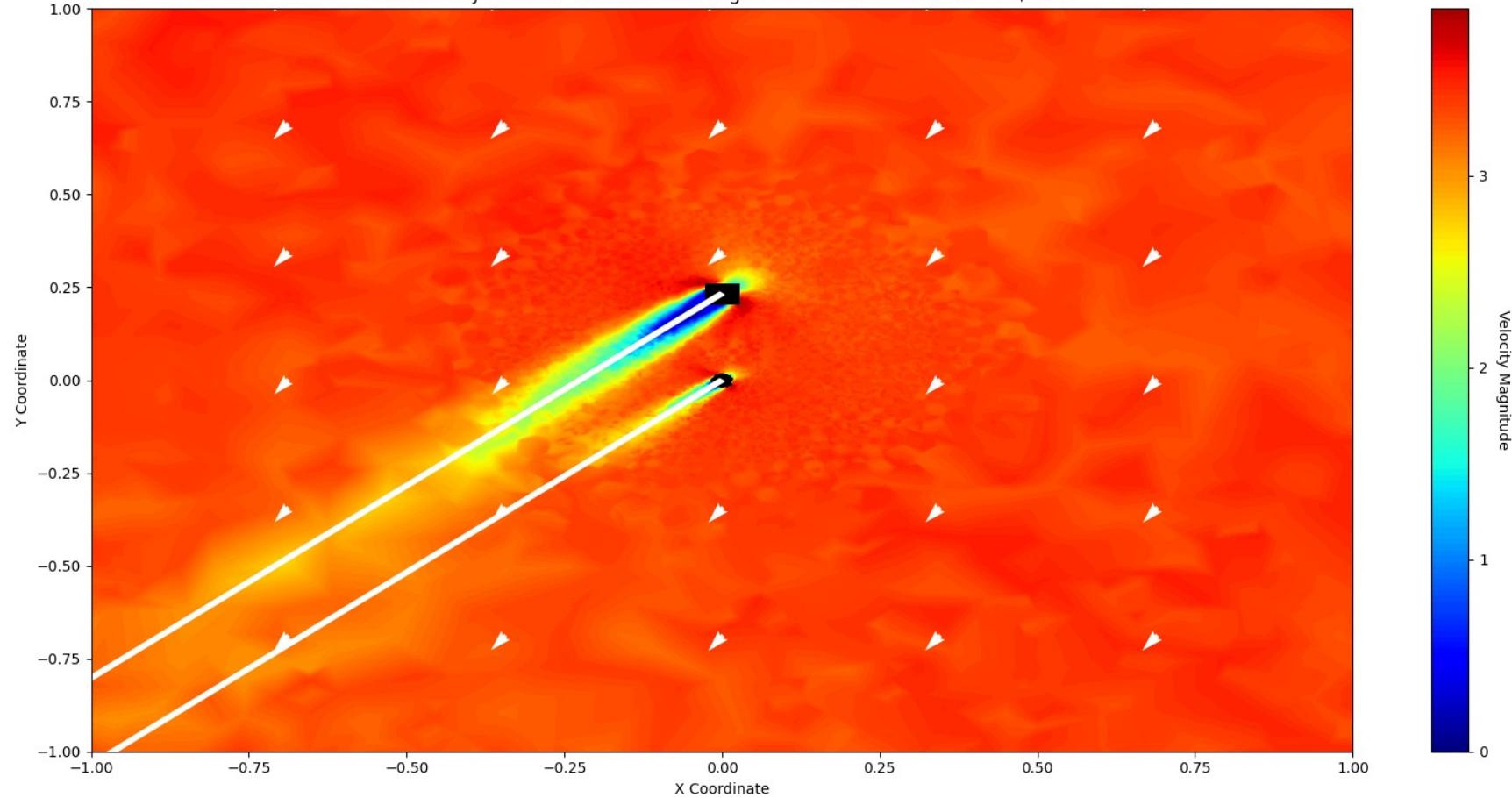
Total Velocity in the X-Y Plane for Wind Angle = 42 with a cut at Z = 0.17 +/- 0.02



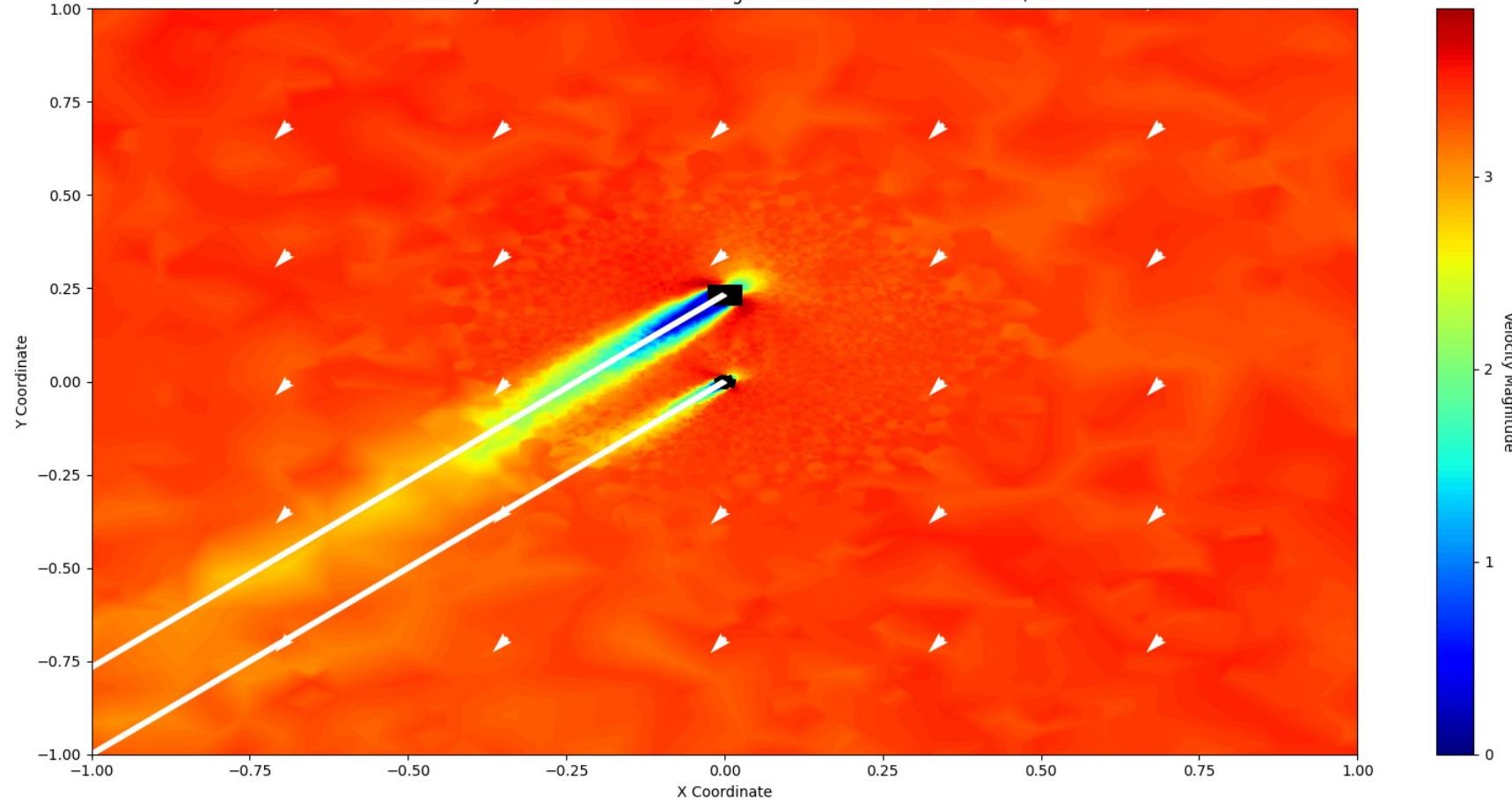
Total Velocity in the X-Y Plane for Wind Angle = 43 with a cut at Z = 0.17 +/- 0.02



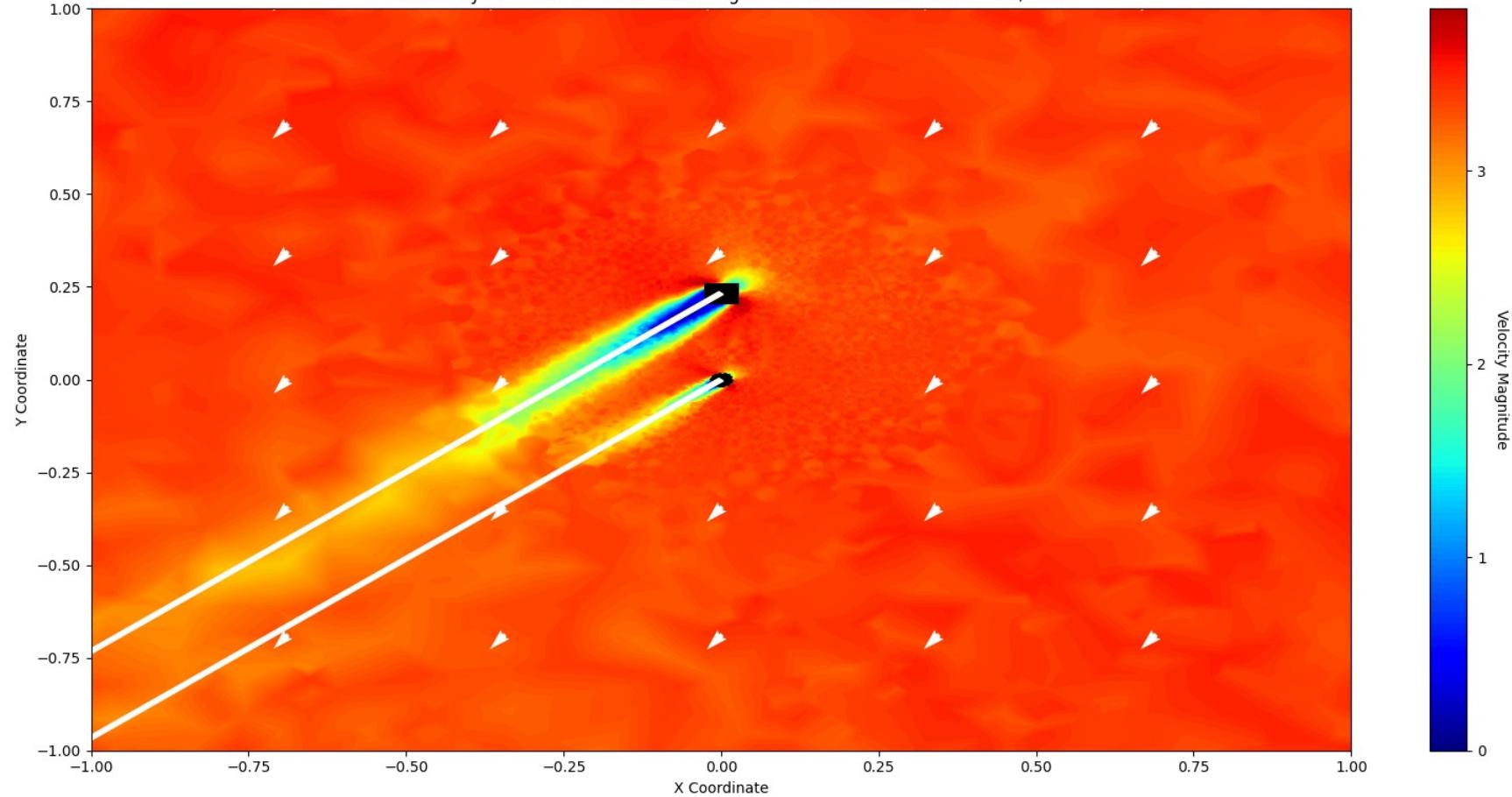
Total Velocity in the X-Y Plane for Wind Angle = 44 with a cut at Z = 0.17 +/- 0.02



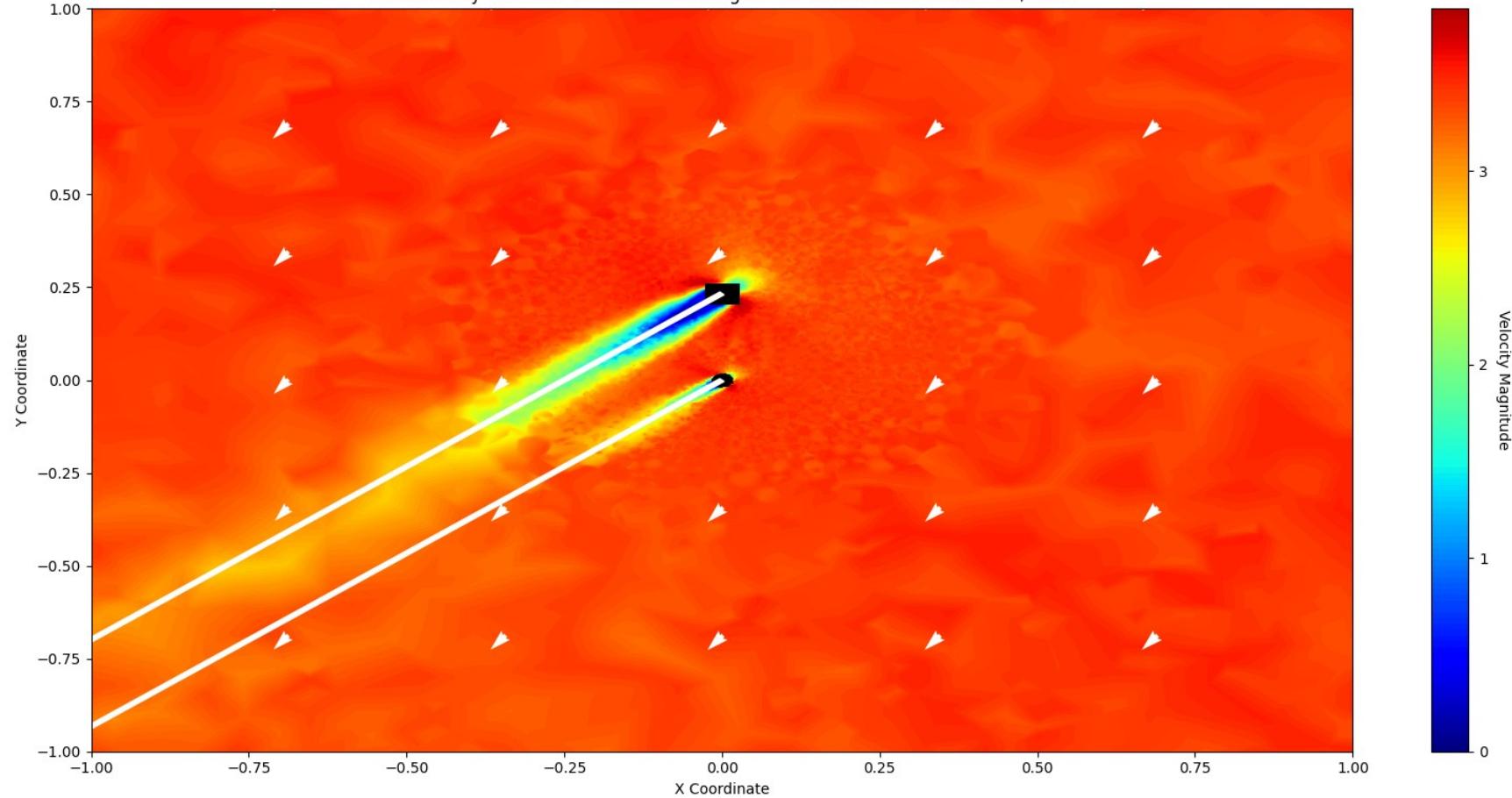
Total Velocity in the X-Y Plane for Wind Angle = 45 with a cut at Z = 0.17 +/- 0.02



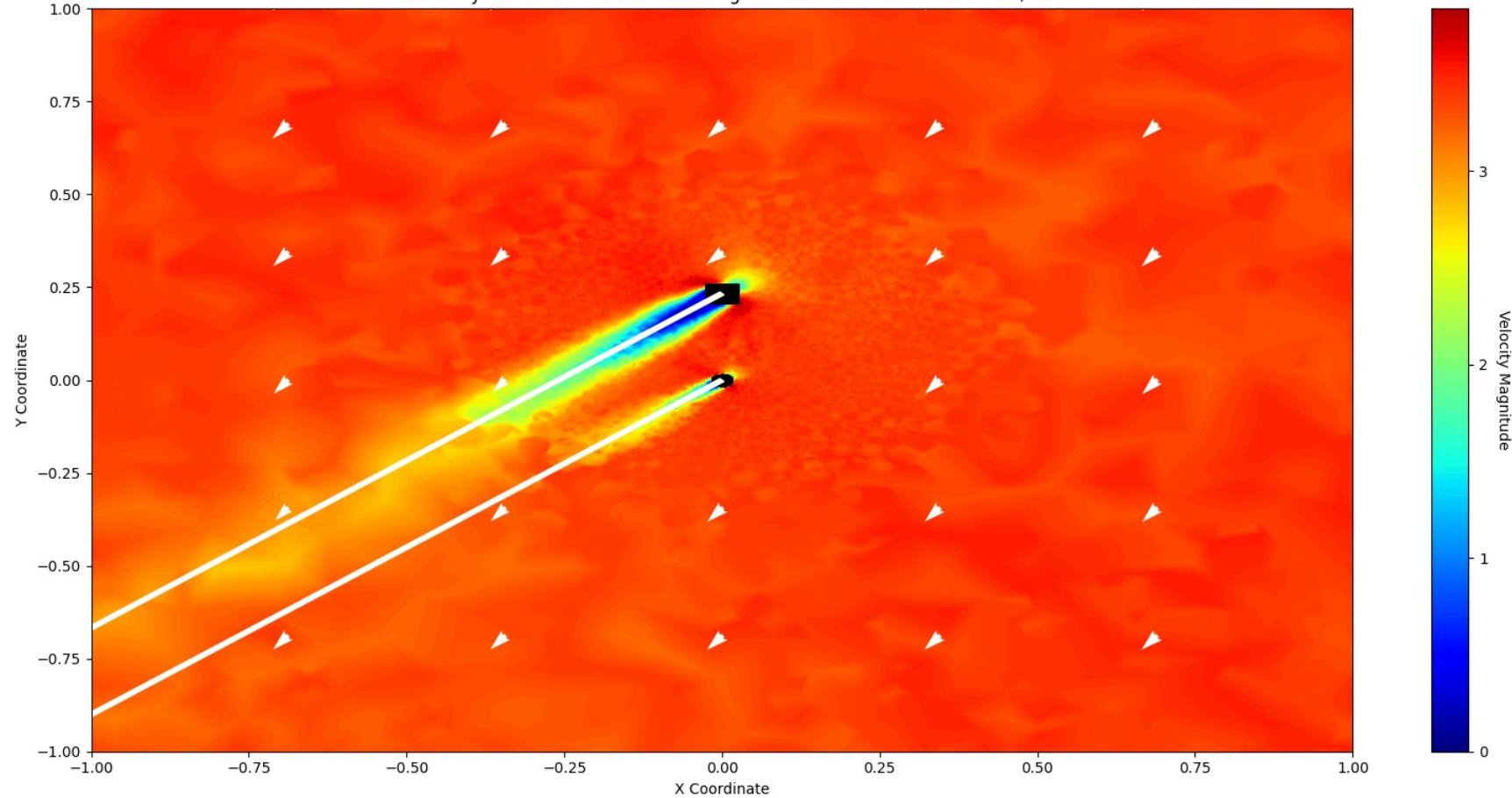
Total Velocity in the X-Y Plane for Wind Angle = 46 with a cut at Z = 0.17 +/- 0.02



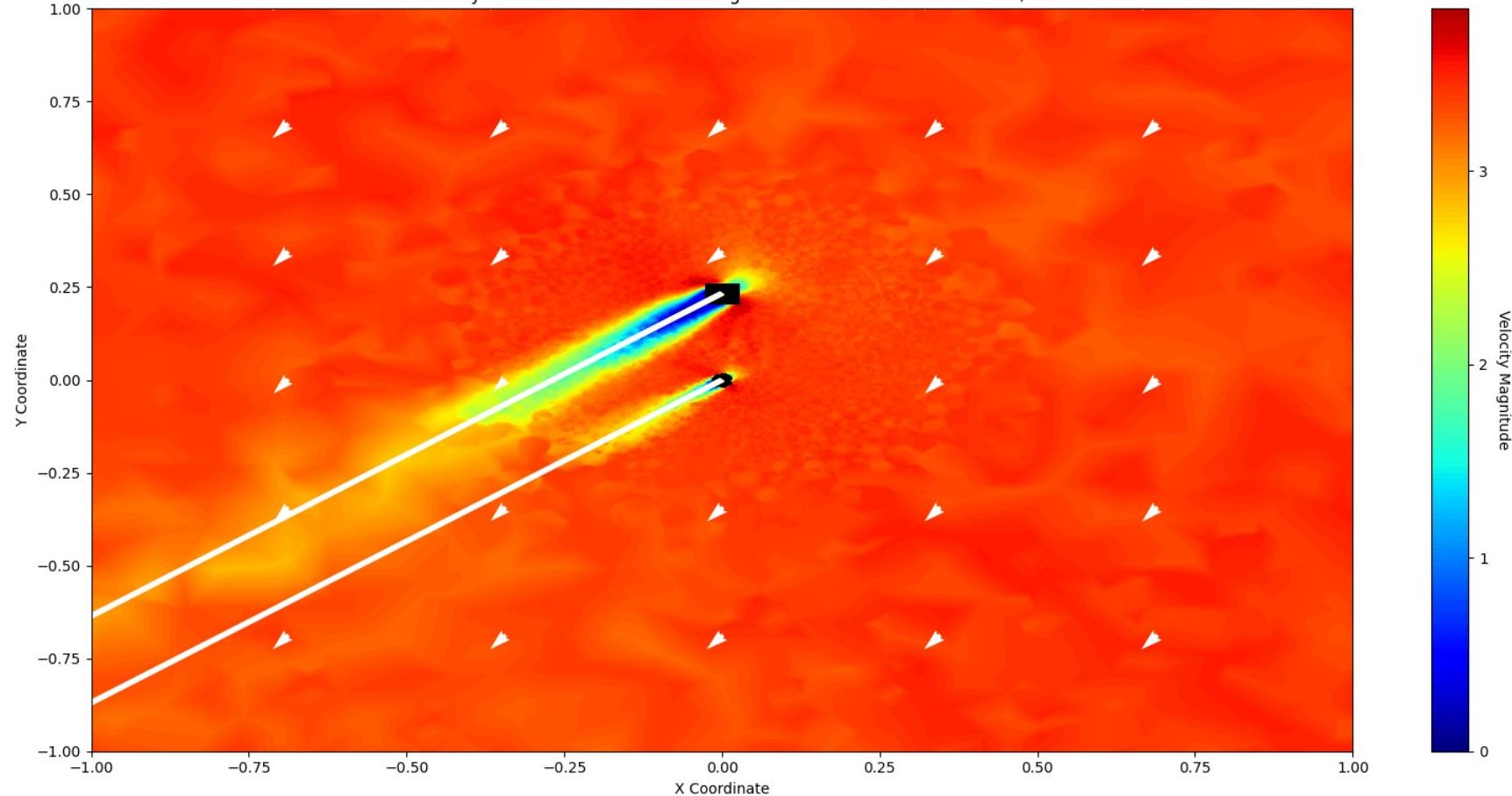
Total Velocity in the X-Y Plane for Wind Angle = 47 with a cut at Z = 0.17 +/- 0.02



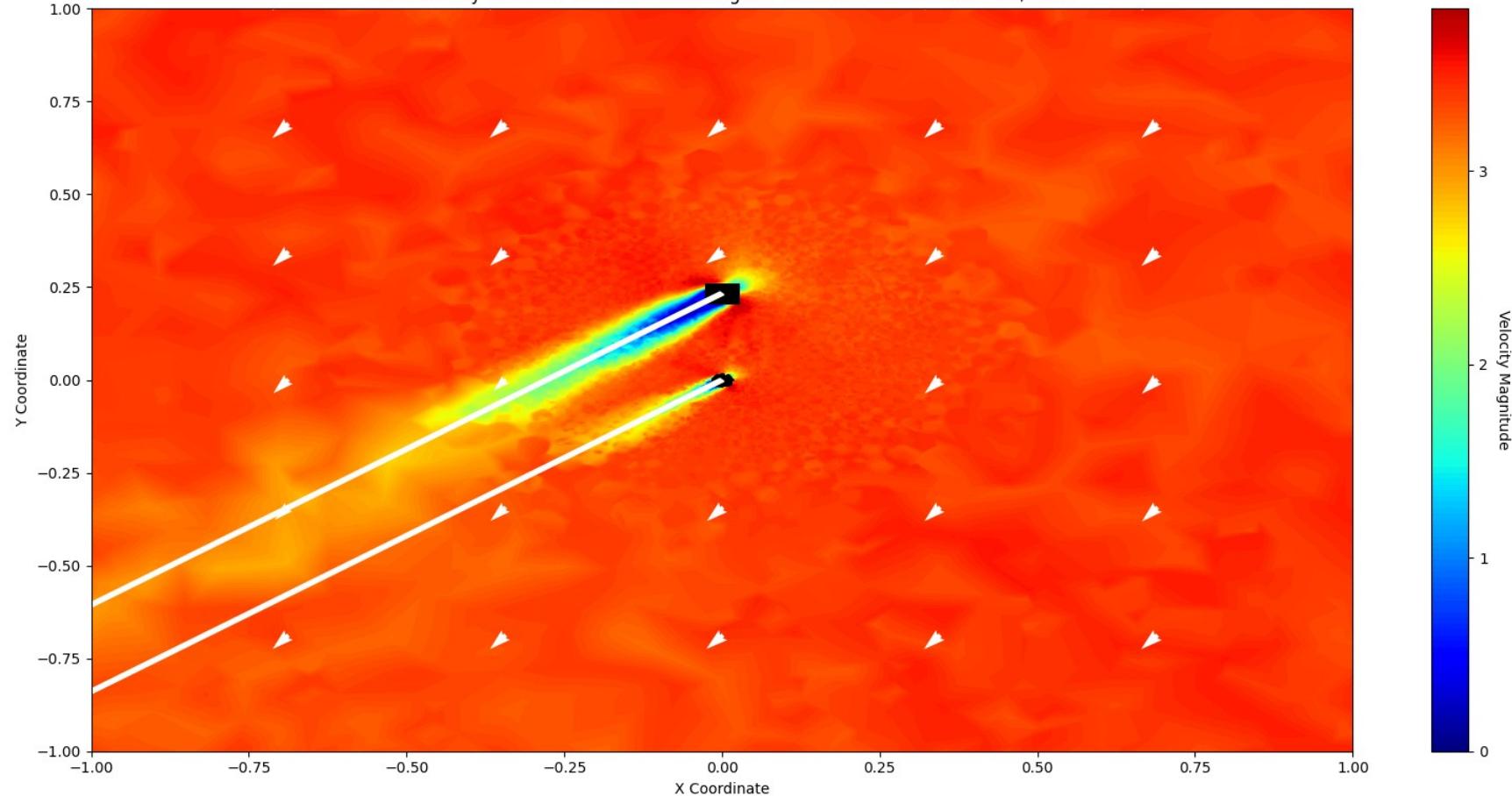
Total Velocity in the X-Y Plane for Wind Angle = 48 with a cut at Z = 0.17 +/- 0.02



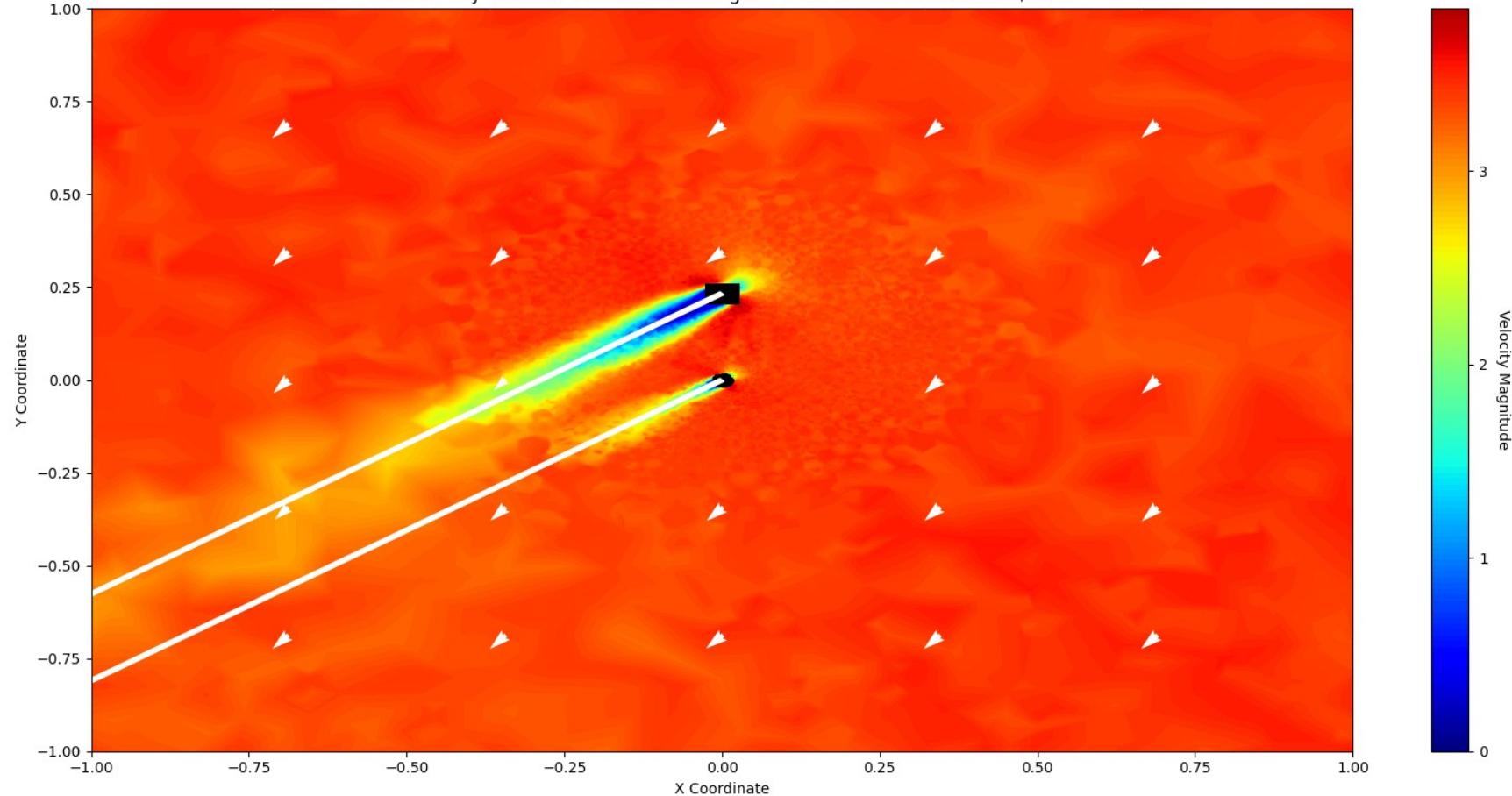
Total Velocity in the X-Y Plane for Wind Angle = 49 with a cut at Z = 0.17 +/- 0.02



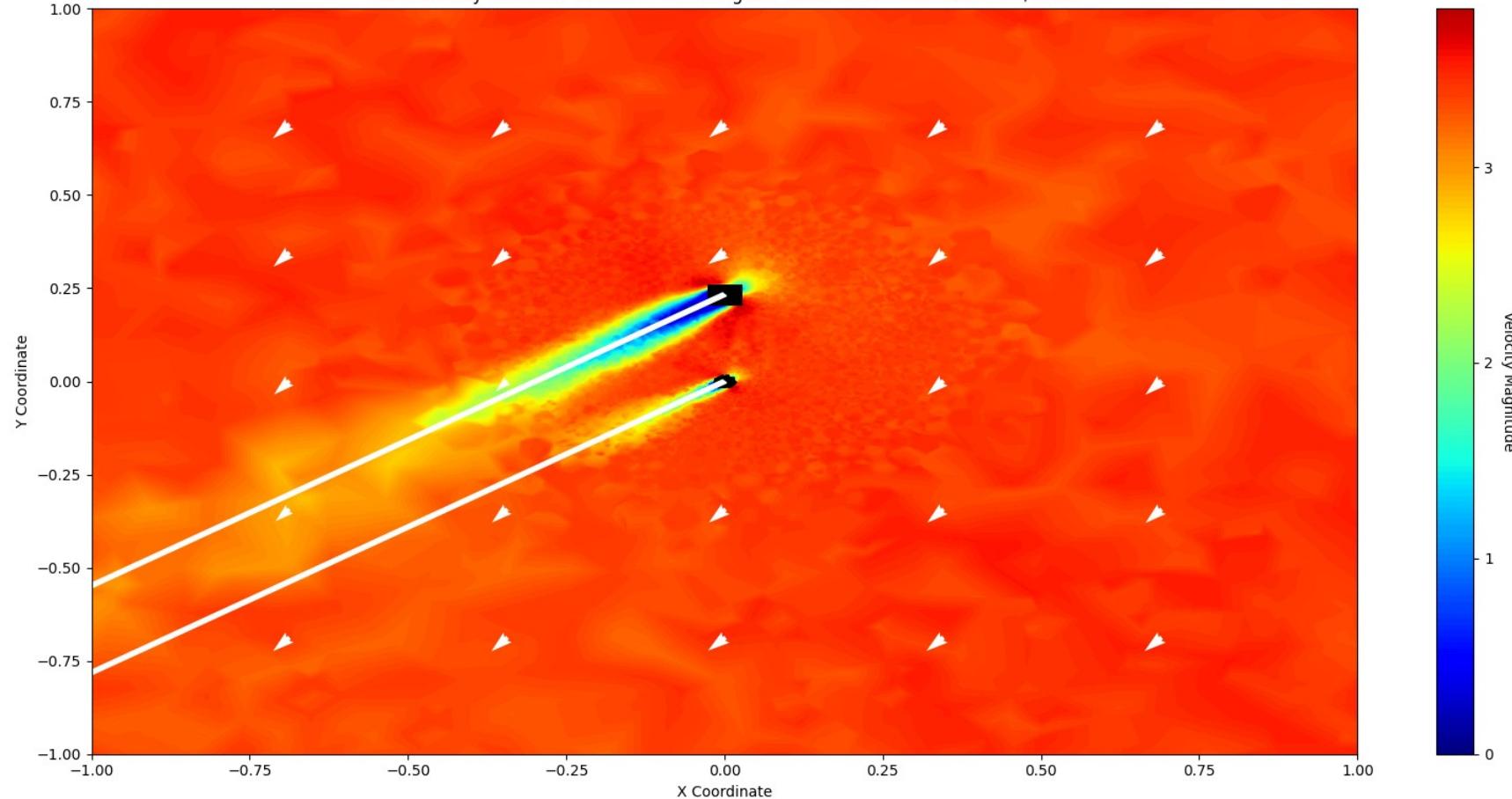
Total Velocity in the X-Y Plane for Wind Angle = 50 with a cut at Z = 0.17 +/- 0.02



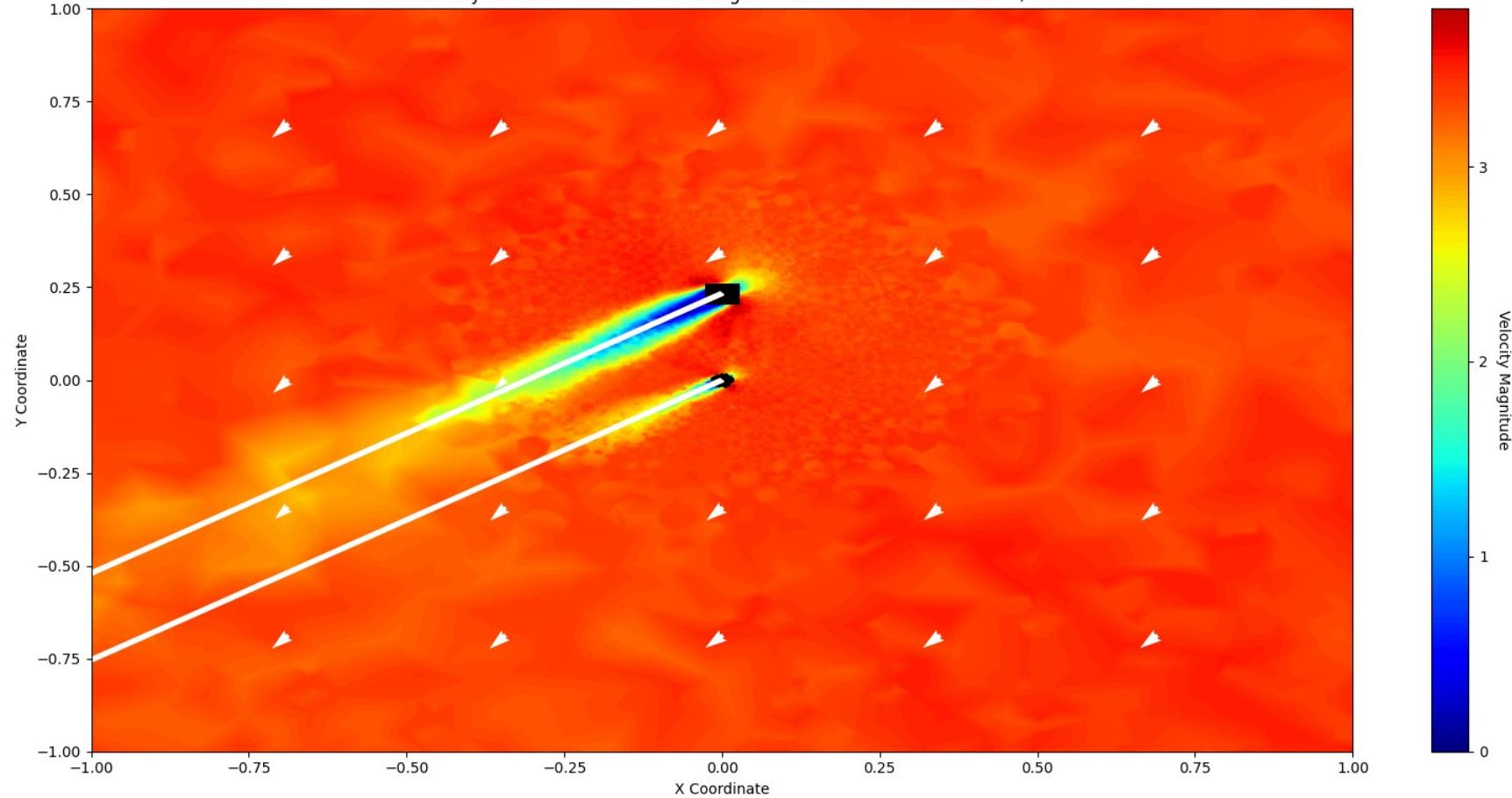
Total Velocity in the X-Y Plane for Wind Angle = 51 with a cut at Z = 0.17 +/- 0.02



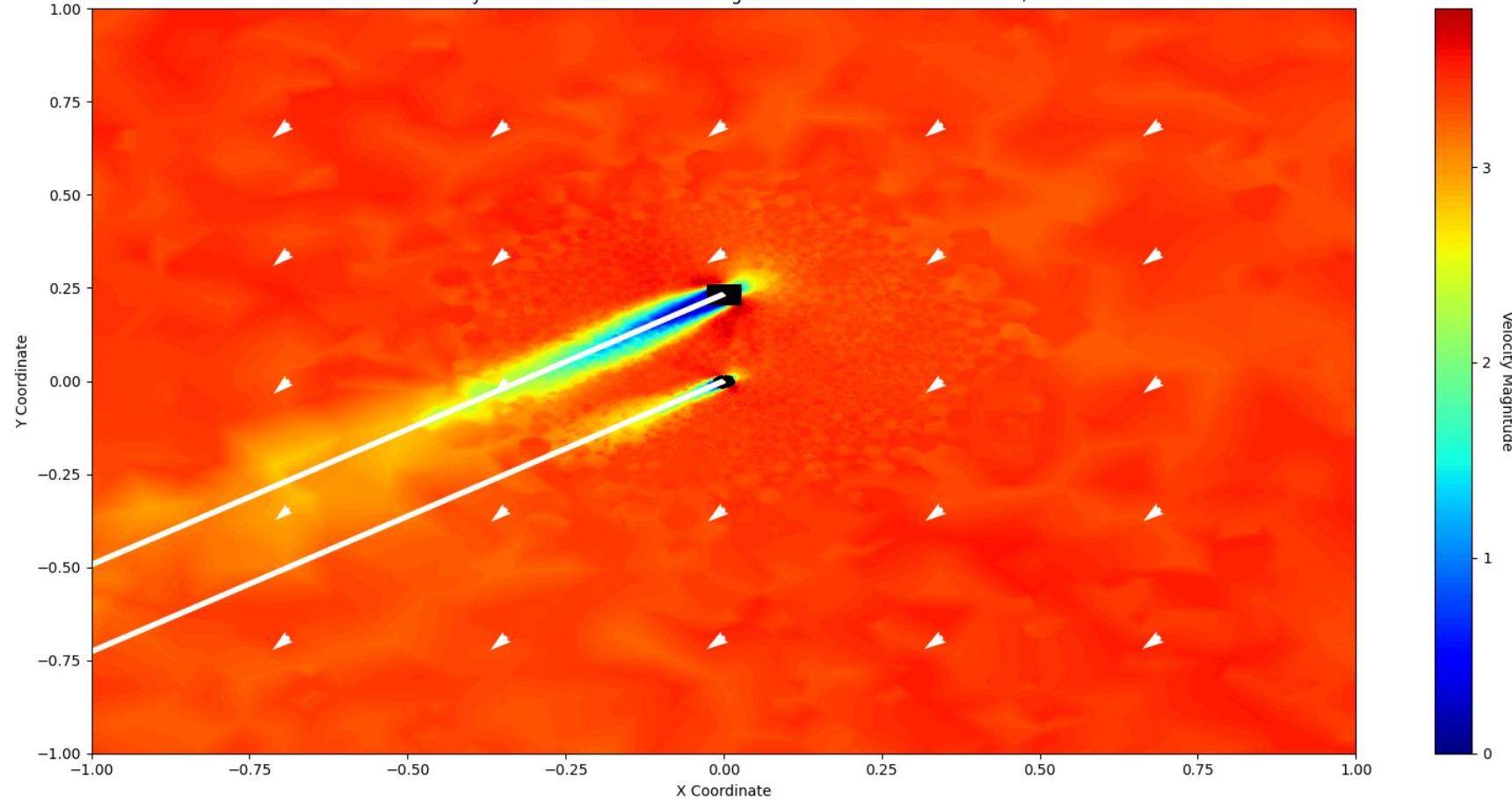
Total Velocity in the X-Y Plane for Wind Angle = 52 with a cut at Z = 0.17 +/- 0.02



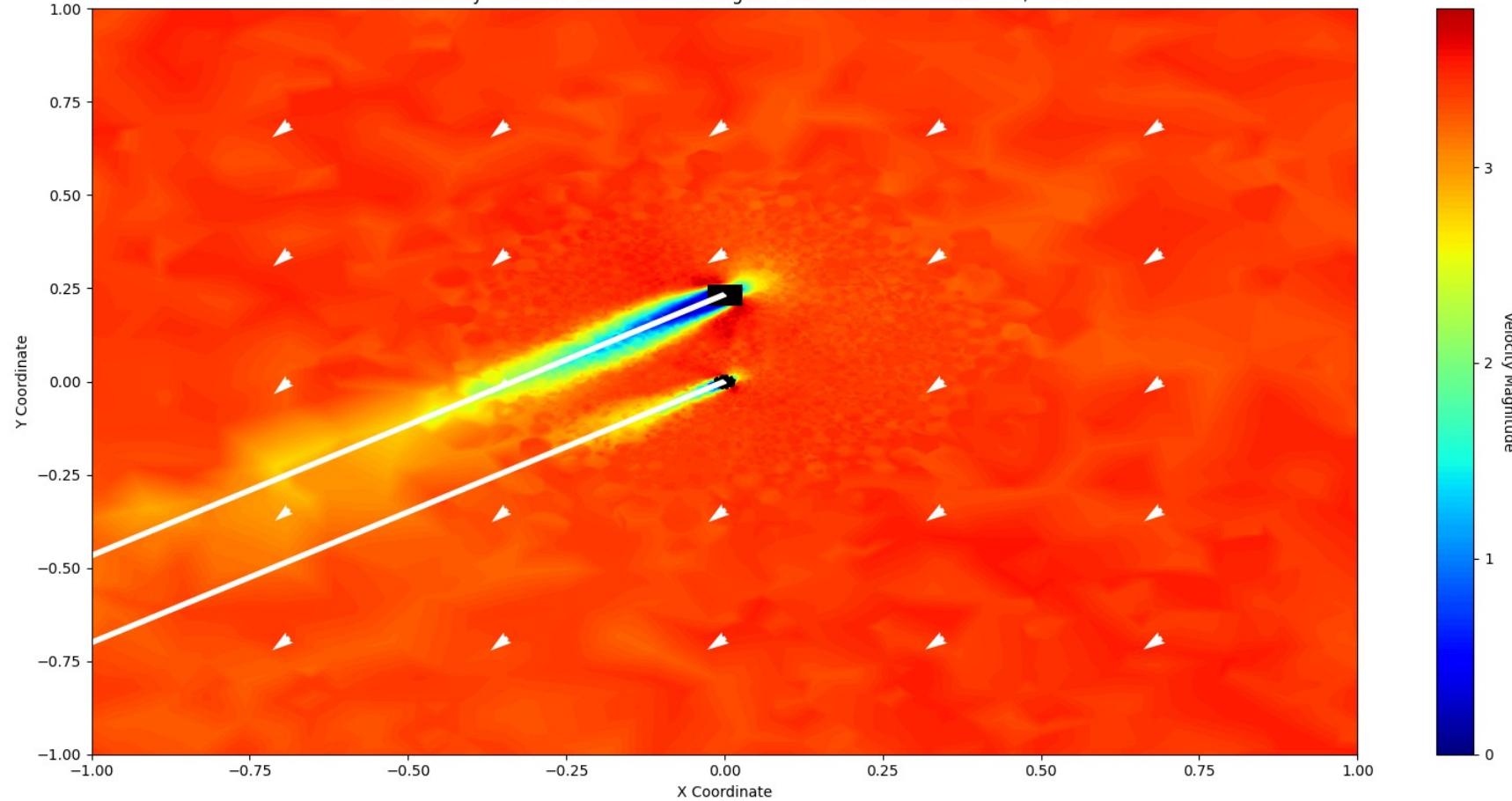
Total Velocity in the X-Y Plane for Wind Angle = 53 with a cut at Z = 0.17 +/- 0.02



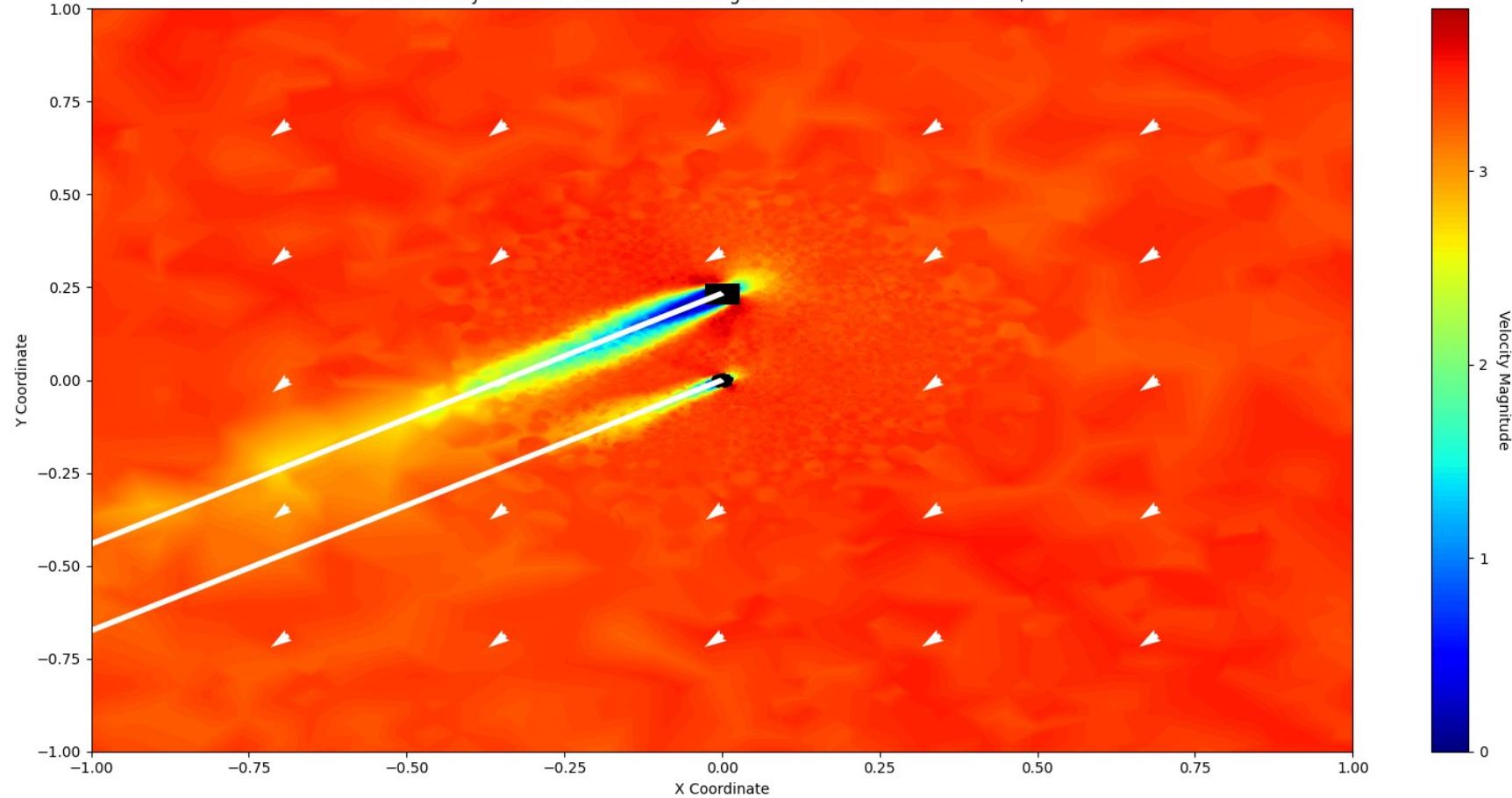
Total Velocity in the X-Y Plane for Wind Angle = 54 with a cut at Z = 0.17 +/- 0.02



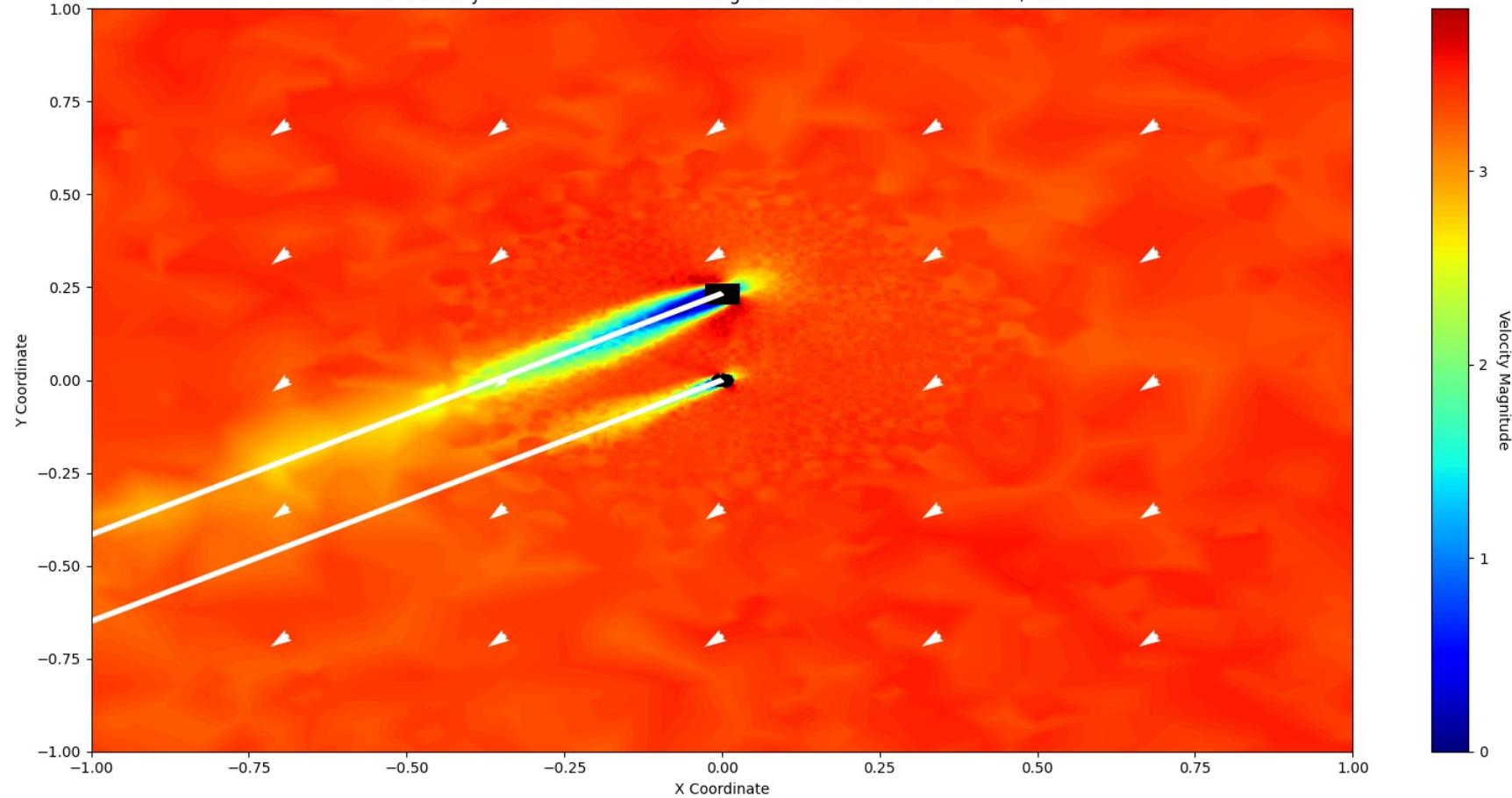
Total Velocity in the X-Y Plane for Wind Angle = 55 with a cut at Z = 0.17 +/- 0.02



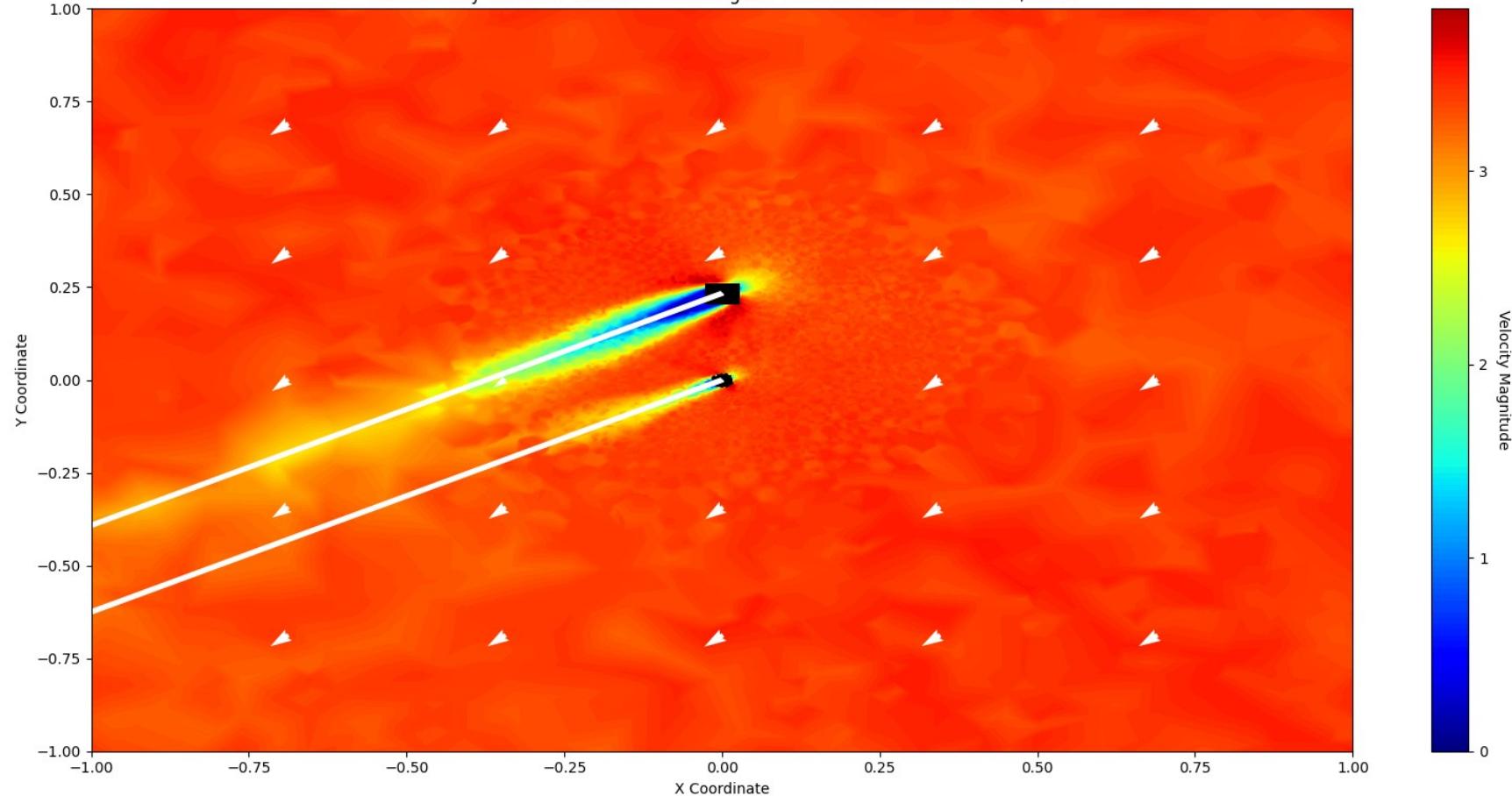
Total Velocity in the X-Y Plane for Wind Angle = 56 with a cut at Z = 0.17 +/- 0.02



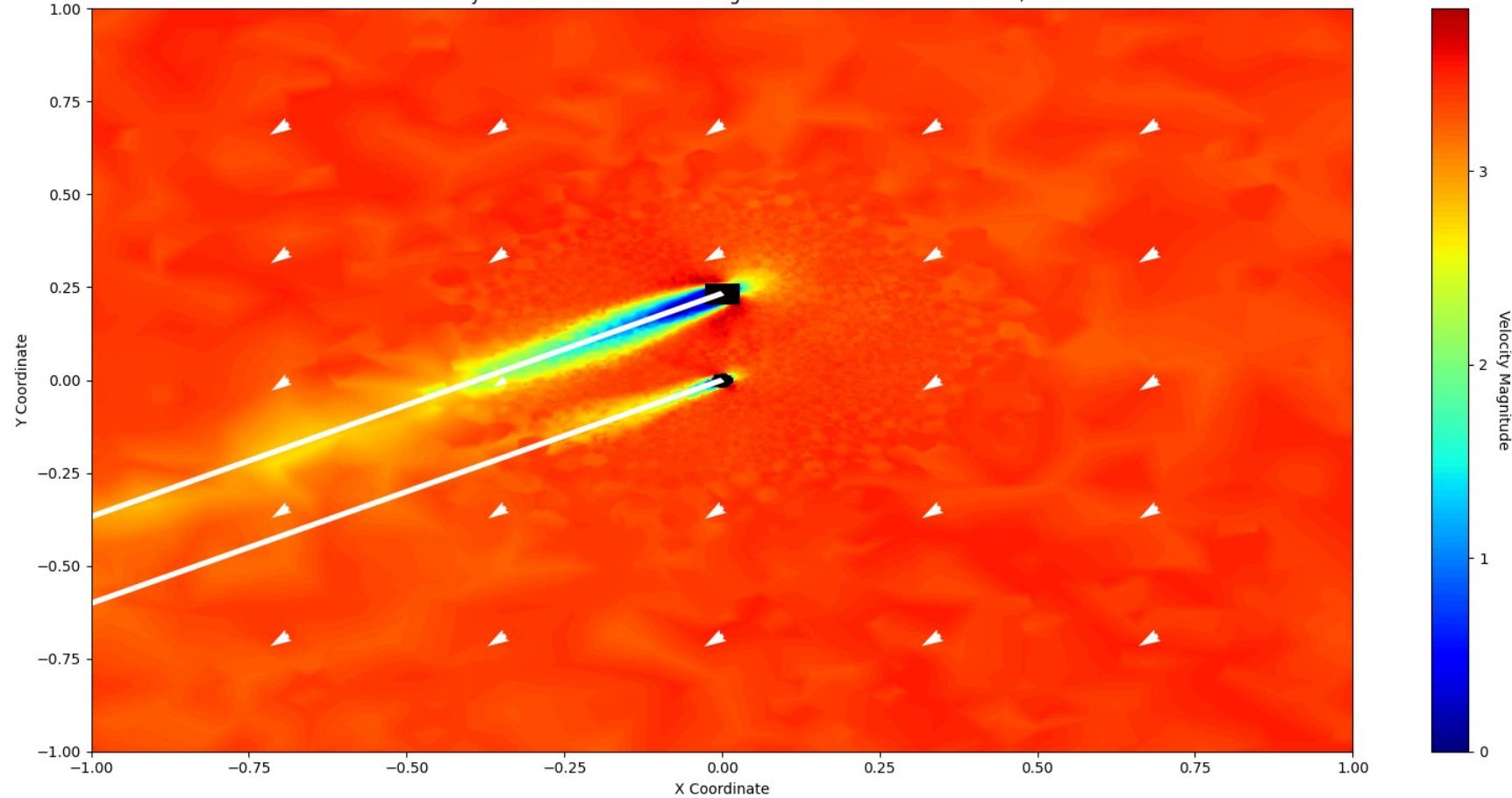
Total Velocity in the X-Y Plane for Wind Angle = 57 with a cut at Z = 0.17 +/- 0.02



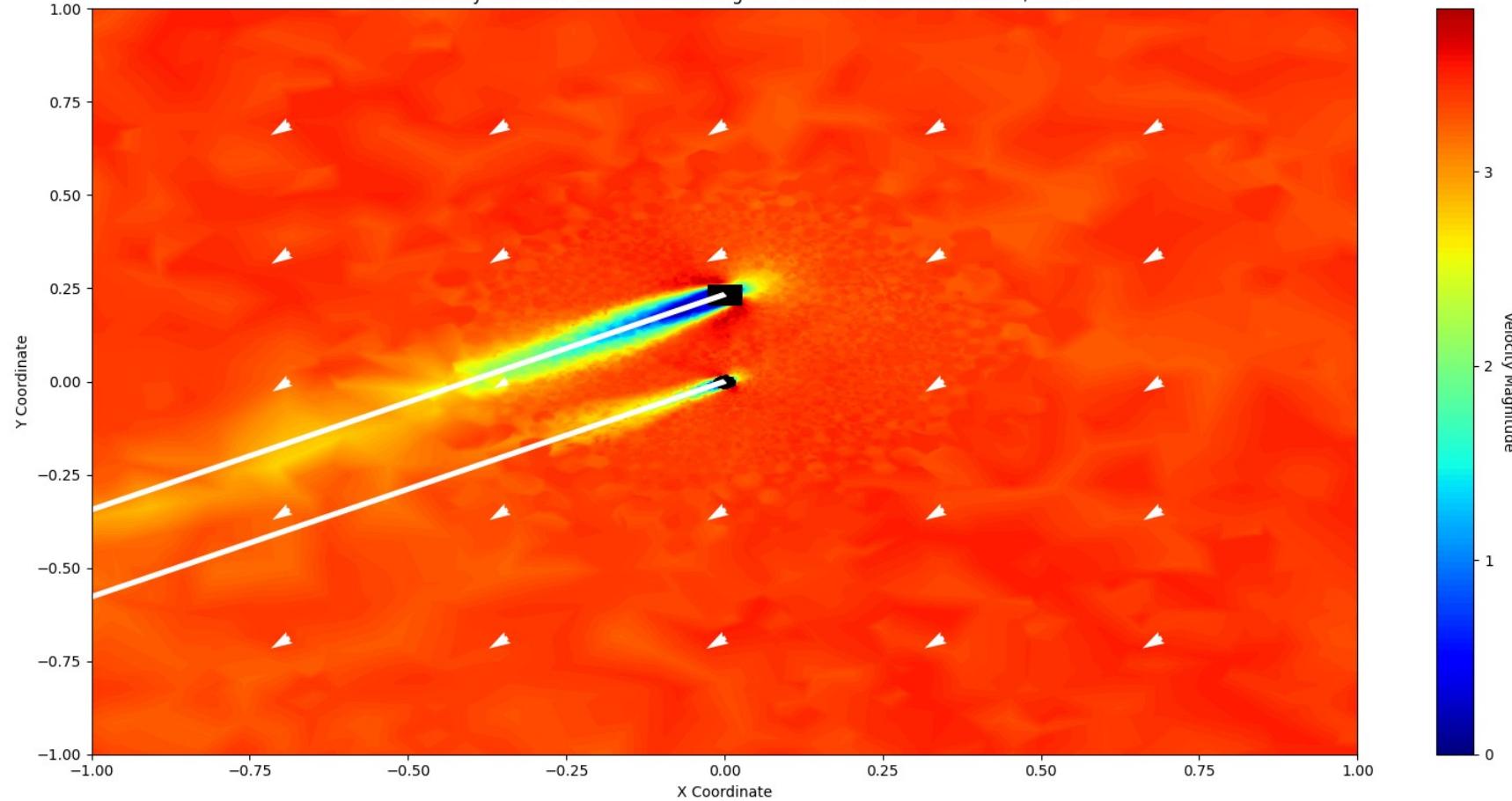
Total Velocity in the X-Y Plane for Wind Angle = 58 with a cut at Z = 0.17 +/- 0.02



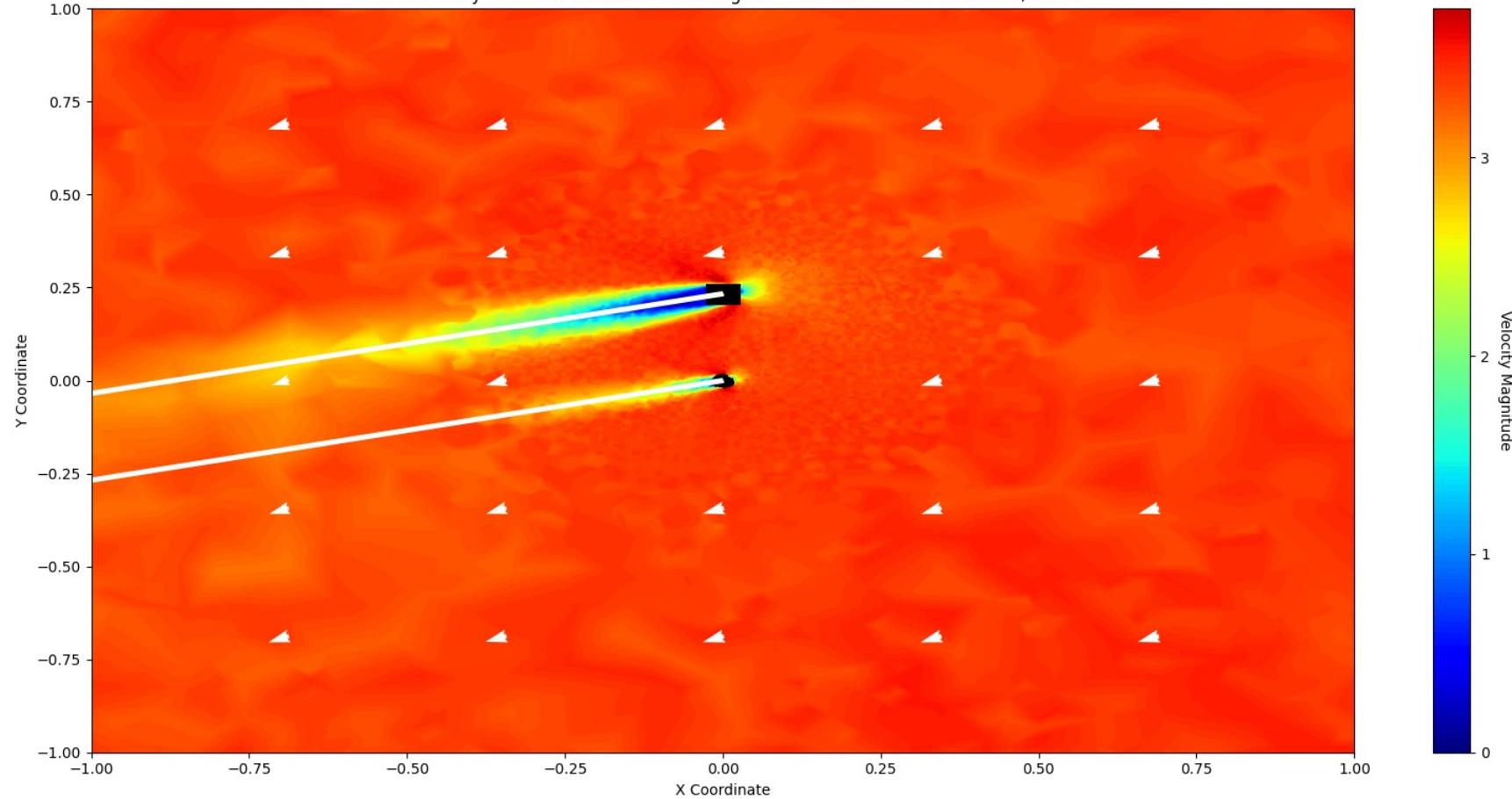
Total Velocity in the X-Y Plane for Wind Angle = 59 with a cut at Z = 0.17 +/- 0.02



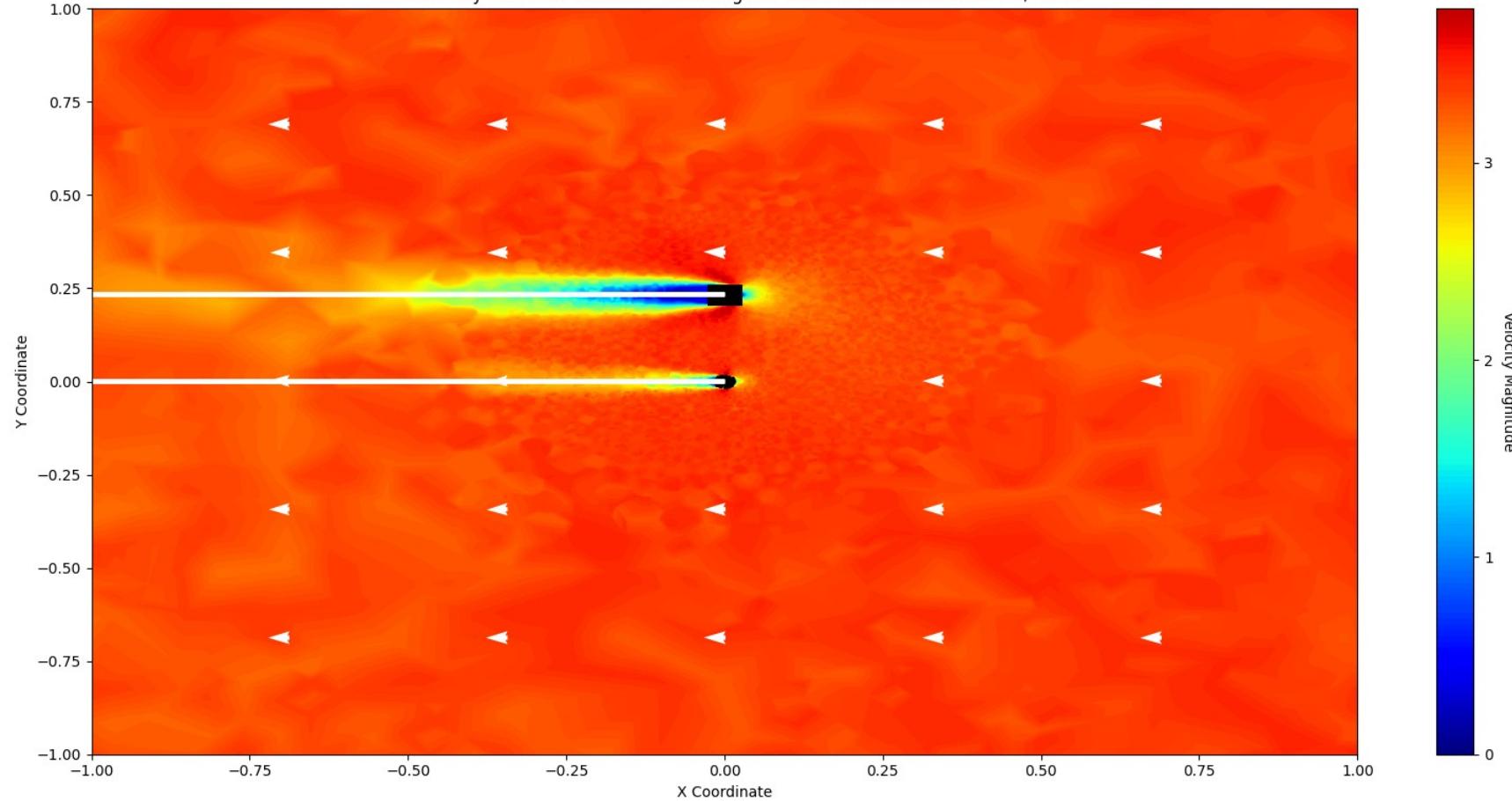
Total Velocity in the X-Y Plane for Wind Angle = 60 with a cut at Z = 0.17 +/- 0.02



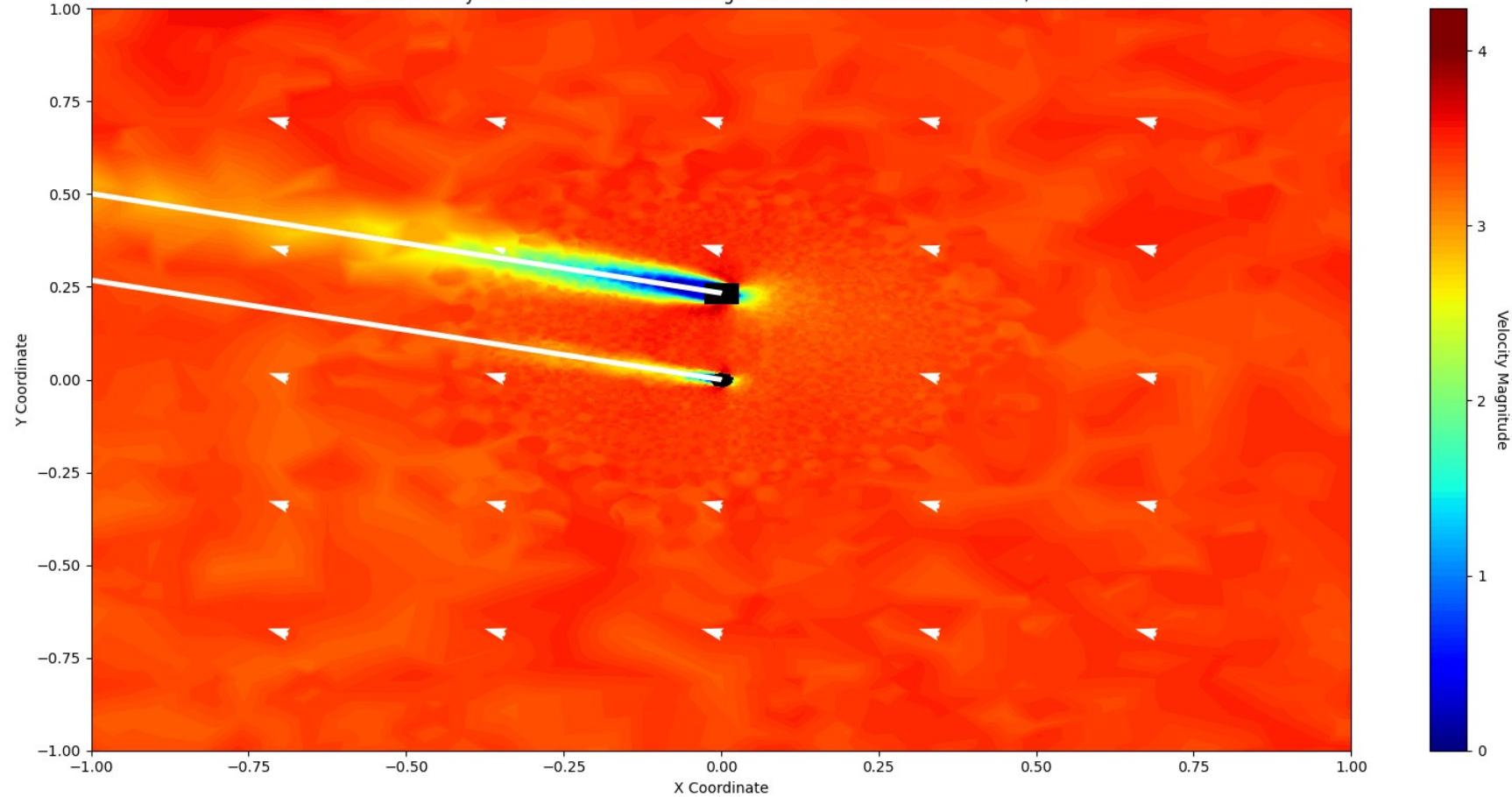
Total Velocity in the X-Y Plane for Wind Angle = 75 with a cut at Z = 0.17 +/- 0.02



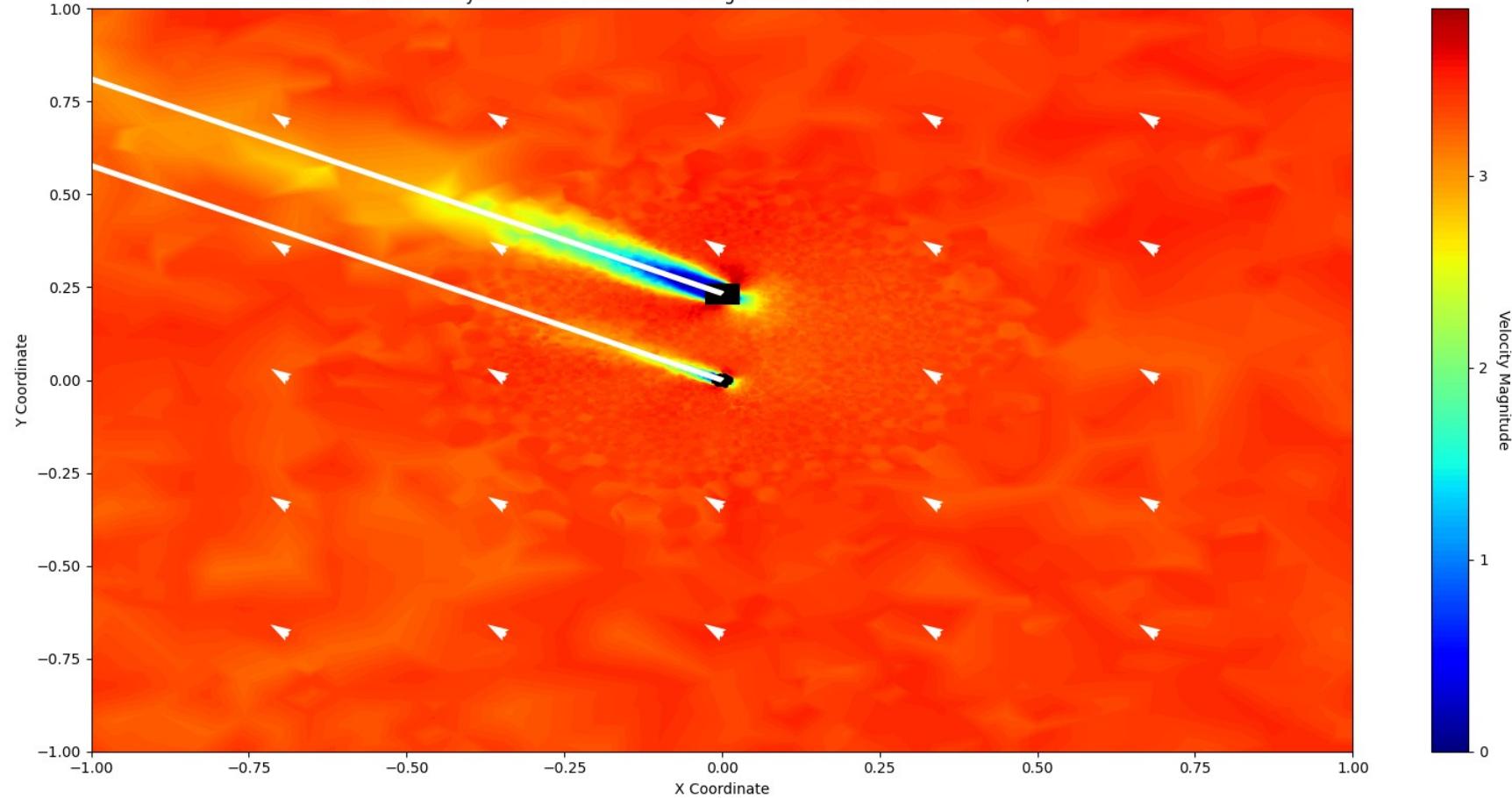
Total Velocity in the X-Y Plane for Wind Angle = 90 with a cut at Z = 0.17 +/- 0.02



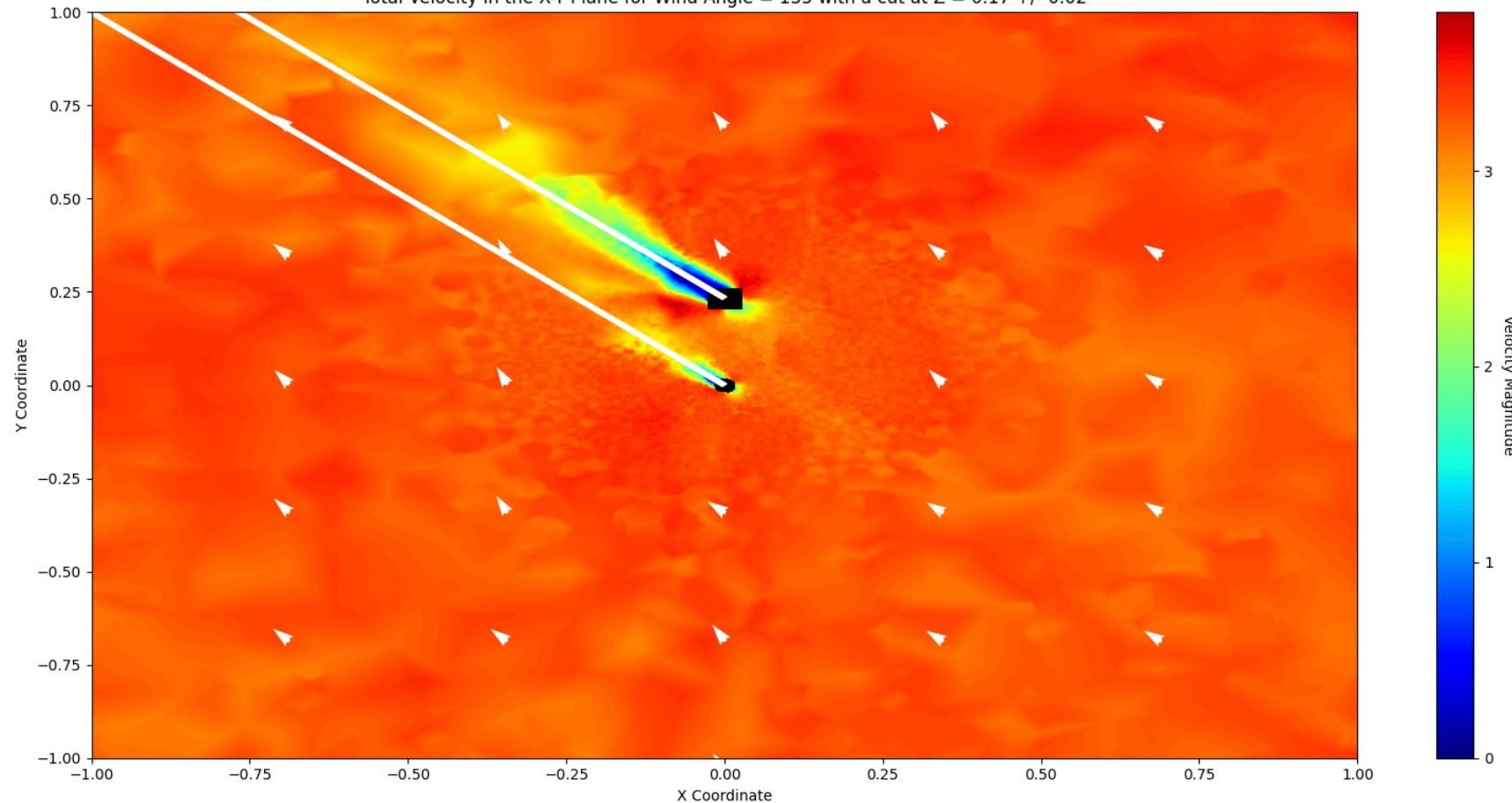
Total Velocity in the X-Y Plane for Wind Angle = 105 with a cut at Z = 0.17 +/- 0.02



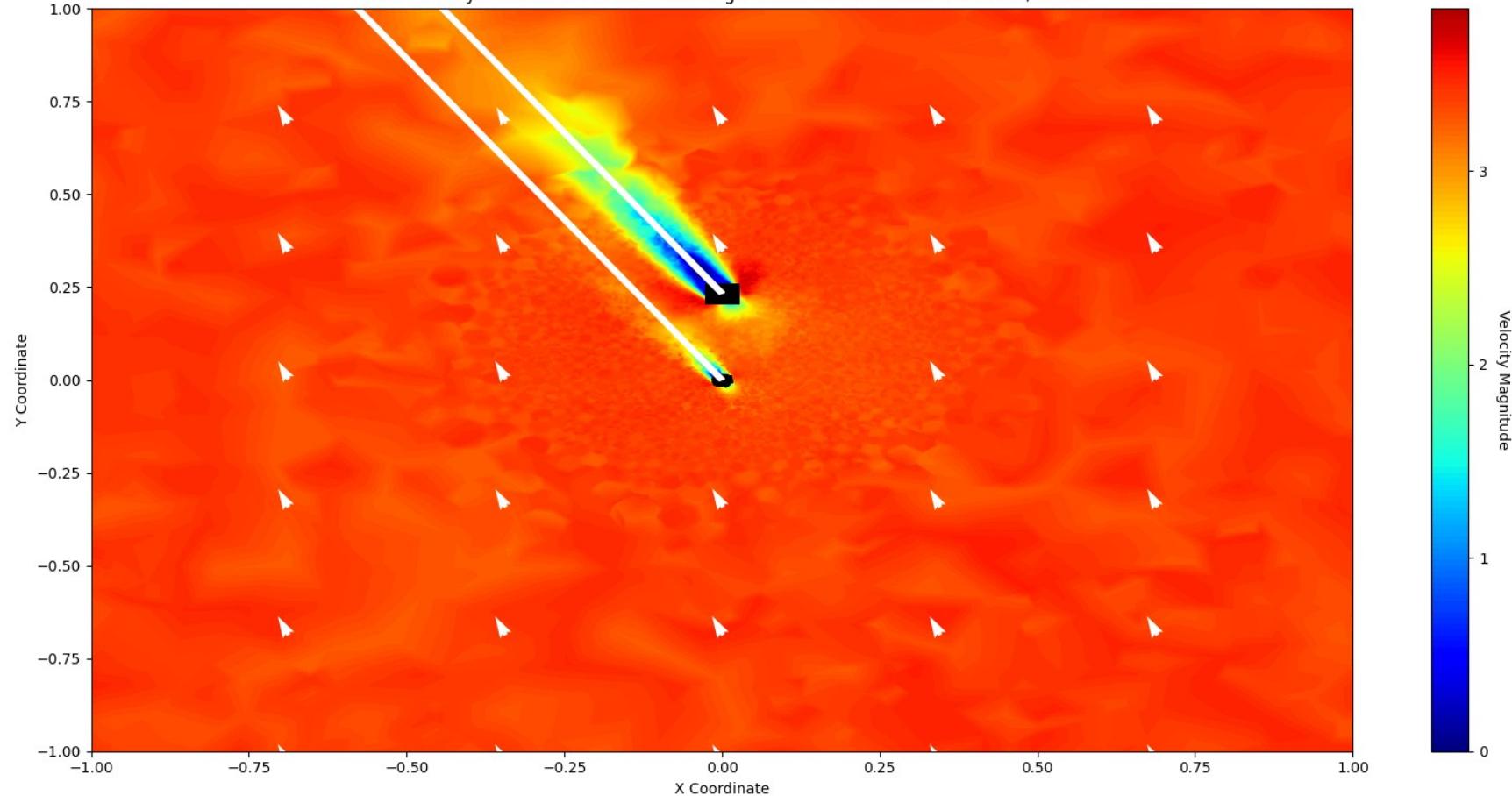
Total Velocity in the X-Y Plane for Wind Angle = 120 with a cut at Z = 0.17 +/- 0.02



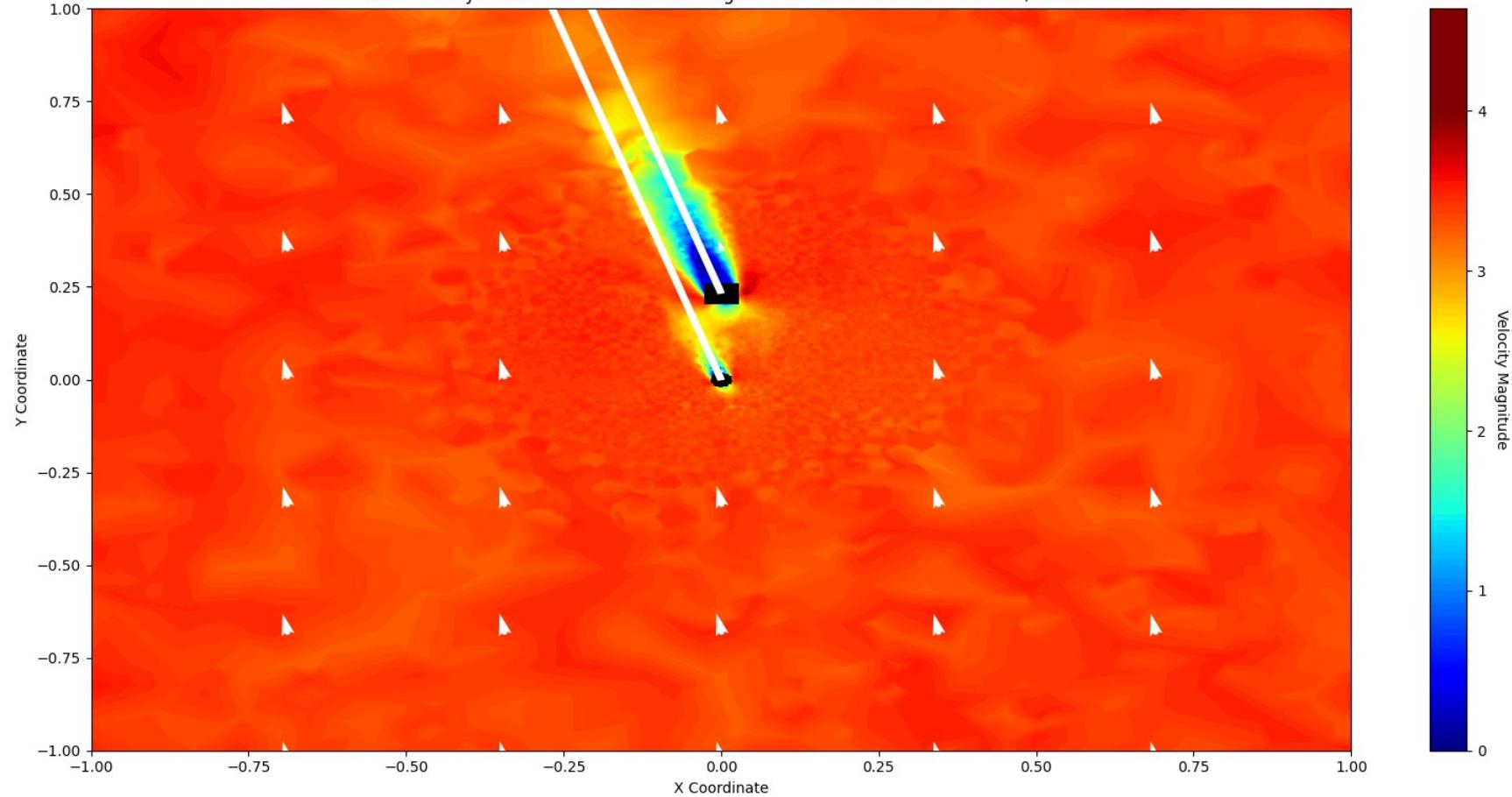
Total Velocity in the X-Y Plane for Wind Angle = 135 with a cut at Z = 0.17 +/- 0.02



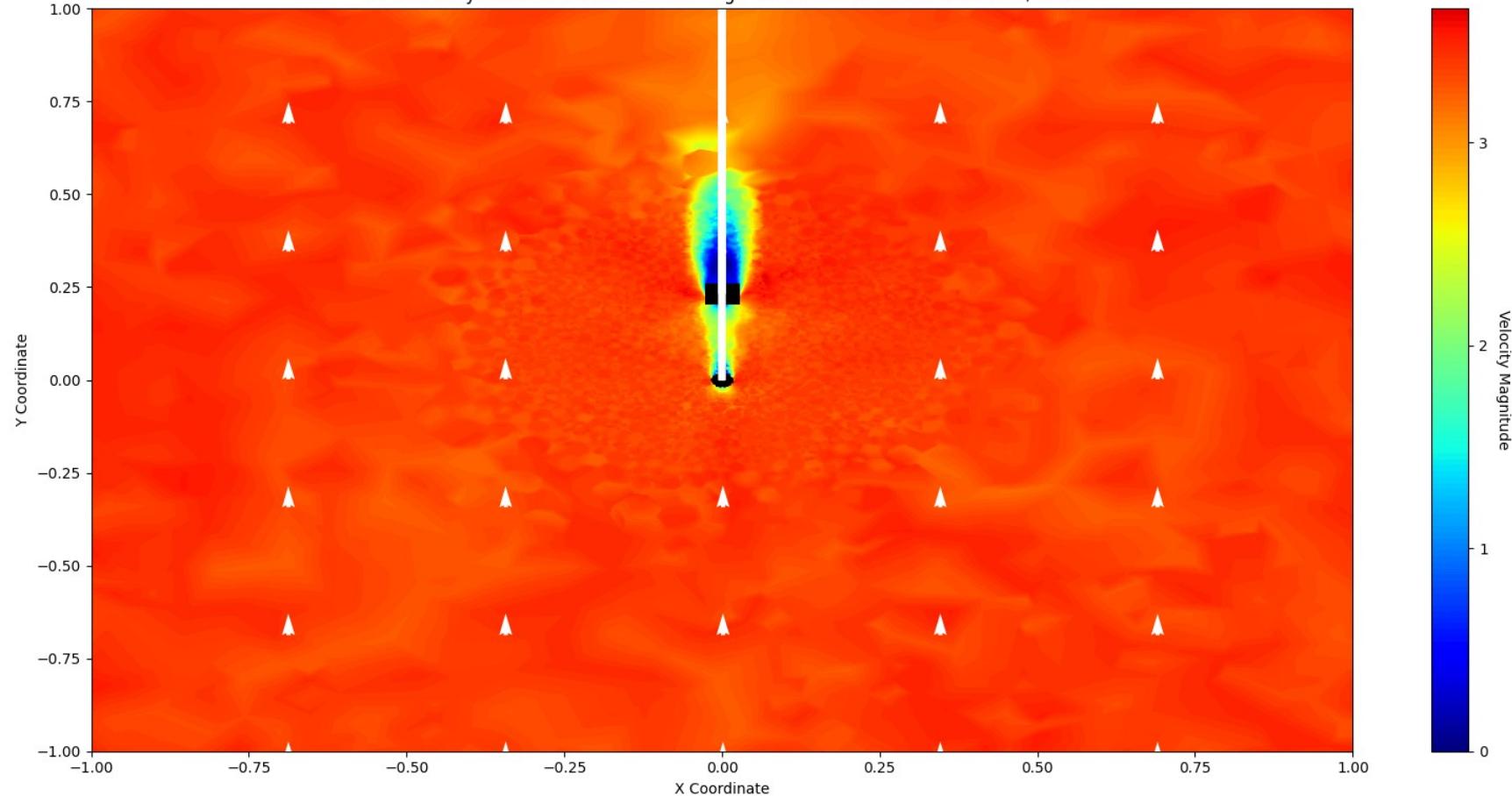
Total Velocity in the X-Y Plane for Wind Angle = 150 with a cut at Z = 0.17 +/- 0.02



Total Velocity in the X-Y Plane for Wind Angle = 165 with a cut at Z = 0.17 +/- 0.02



Total Velocity in the X-Y Plane for Wind Angle = 180 with a cut at Z = 0.17 +/- 0.02



Progress so far - Data + No Slip Loss
Standard Normal Scalar
(Adam Optimizer)

Threshold = 1E-5 (1030 Epochs, not completed), GPU Laptop

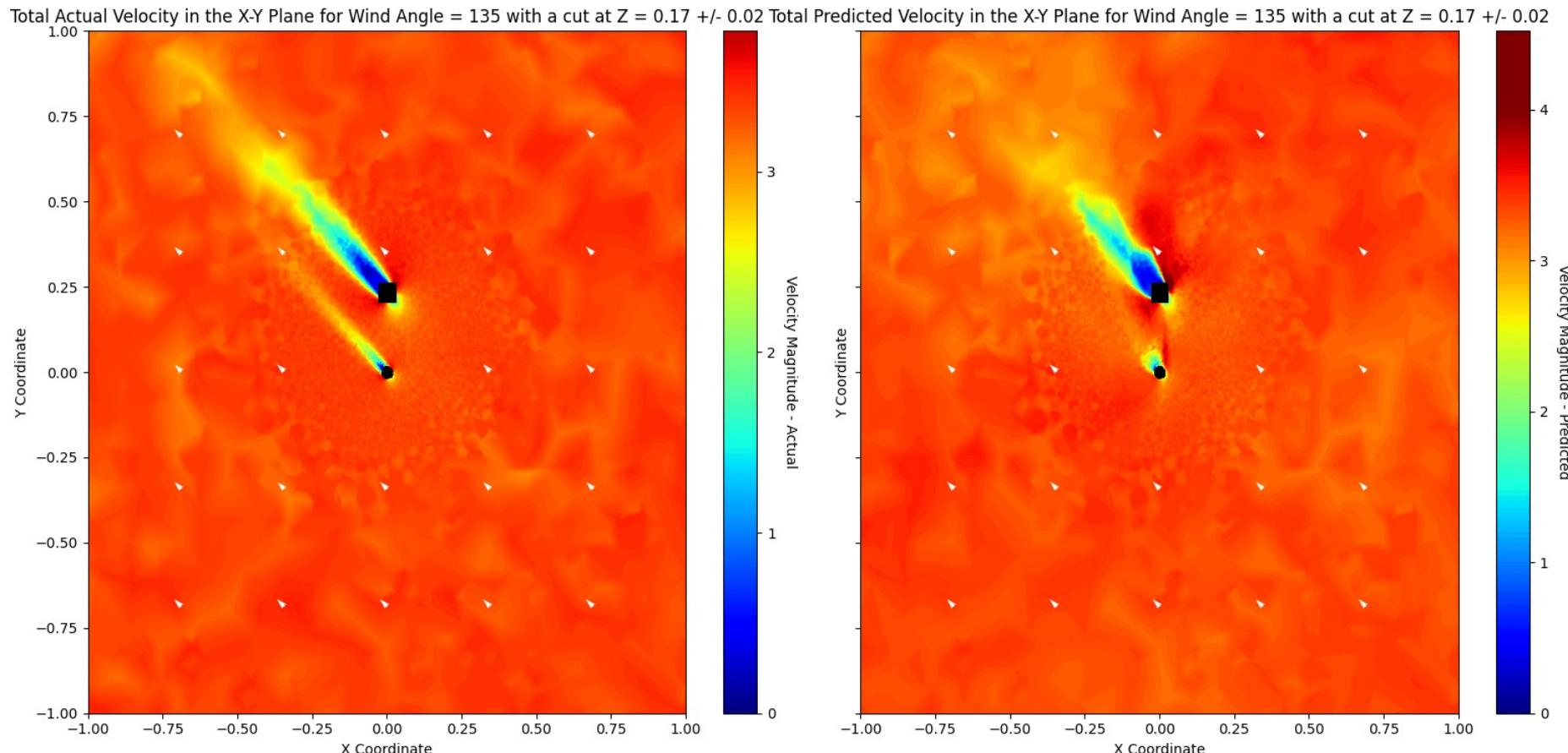
Scripts v4 – PREDICTING (135 DEG)

Progress so far - Data + No Slip Loss (Adam Optimizer – Std Normal Scalar)
Threshold = 1E-5 (1030 Epochs, so far...), GPU Laptop
Predicting Results – Metrics (Angle = 135)

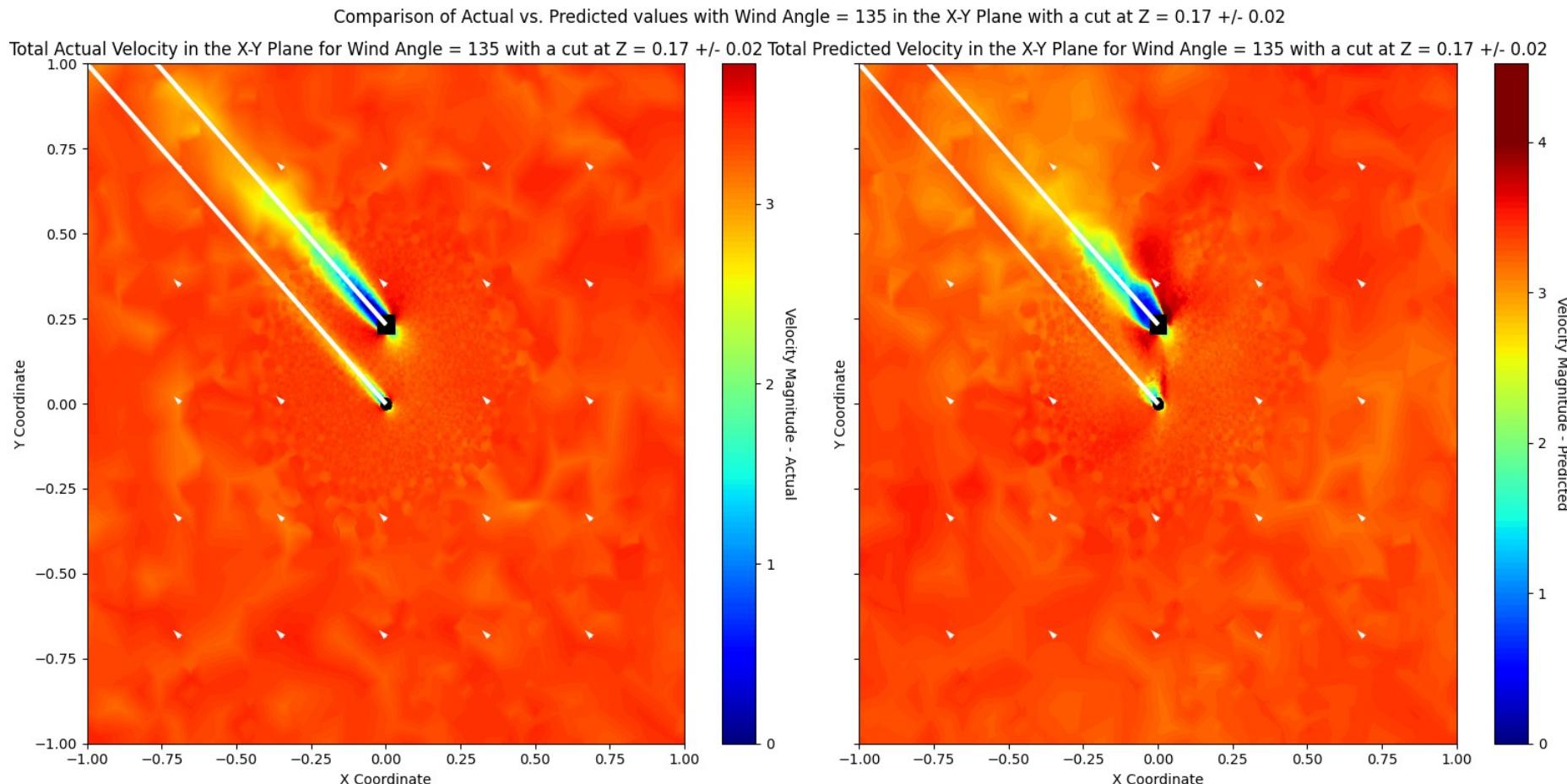
Variable	MSE	RMSE	MAE	R2
Velocity:0	0.0532236924650972	0.230702606108161	0.111288365128735	0.947780346275545
Velocity:1	0.0572523441479038	0.239274620776847	0.133849165568289	0.944363224955807
Velocity:2	0.0075613956141028 4	0.086956285650336	0.0347438806964828	0.768864041595348

Progress so far - Data + No Slip Loss (Adam Optimizer – Std Normal Scalar), Threshold = 1E-5 (1030 Epochs, so far...), GPU Laptop
Predicting Results - X-Y Total Velocity Plot (Angle = 135)

Comparison of Actual vs. Predicted values with Wind Angle = 135 in the X-Y Plane with a cut at Z = 0.17 +/- 0.02



Progress so far - Data + No Slip Loss (Adam Optimizer – Std Normal Scalar), Threshold = 1E-5 (1030 Epochs, so far...), GPU Laptop
Predicting Results - X-Y Total Velocity Plot (Angle = 135)

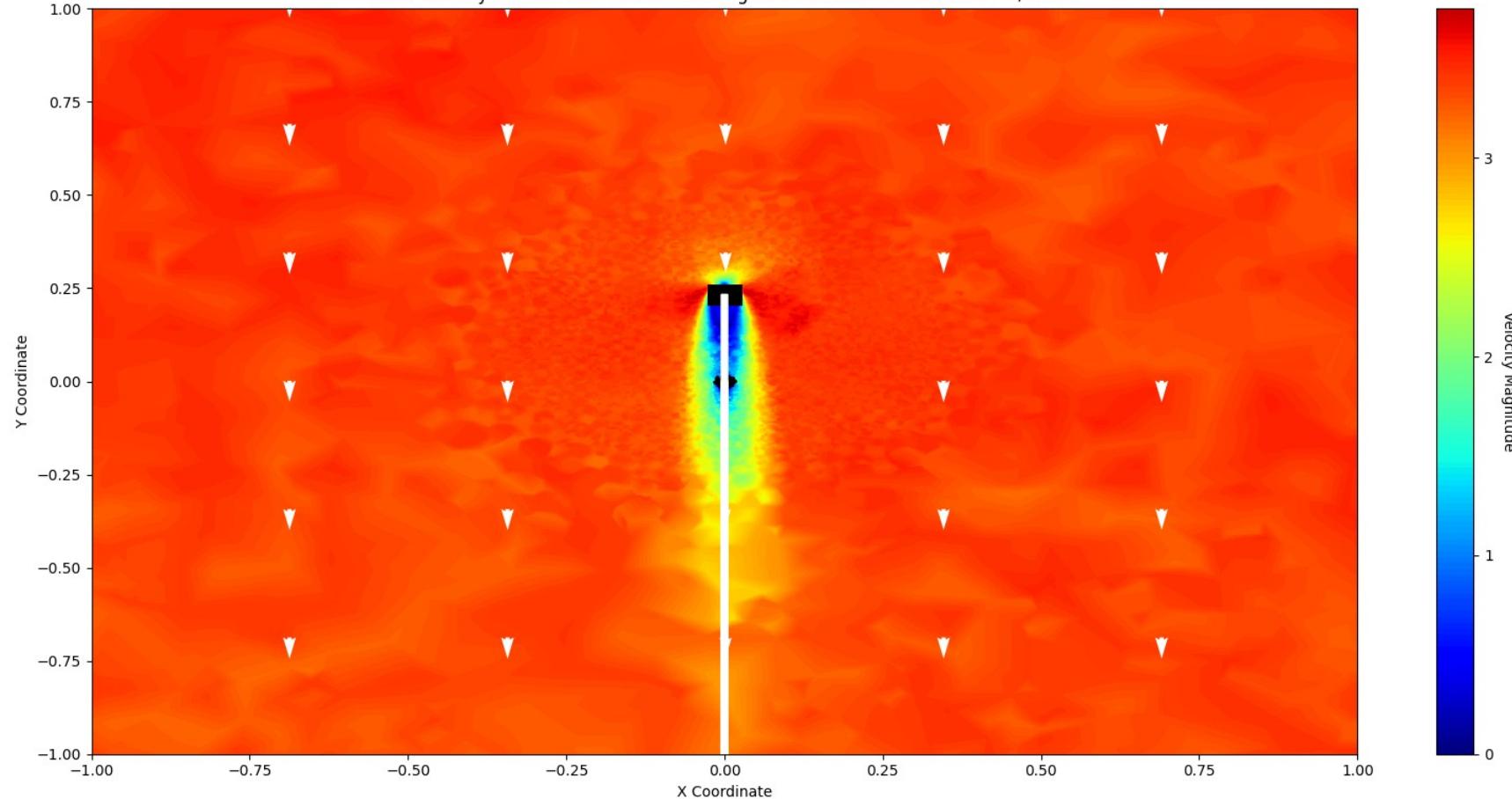


Progress so far - Data + No Slip Loss
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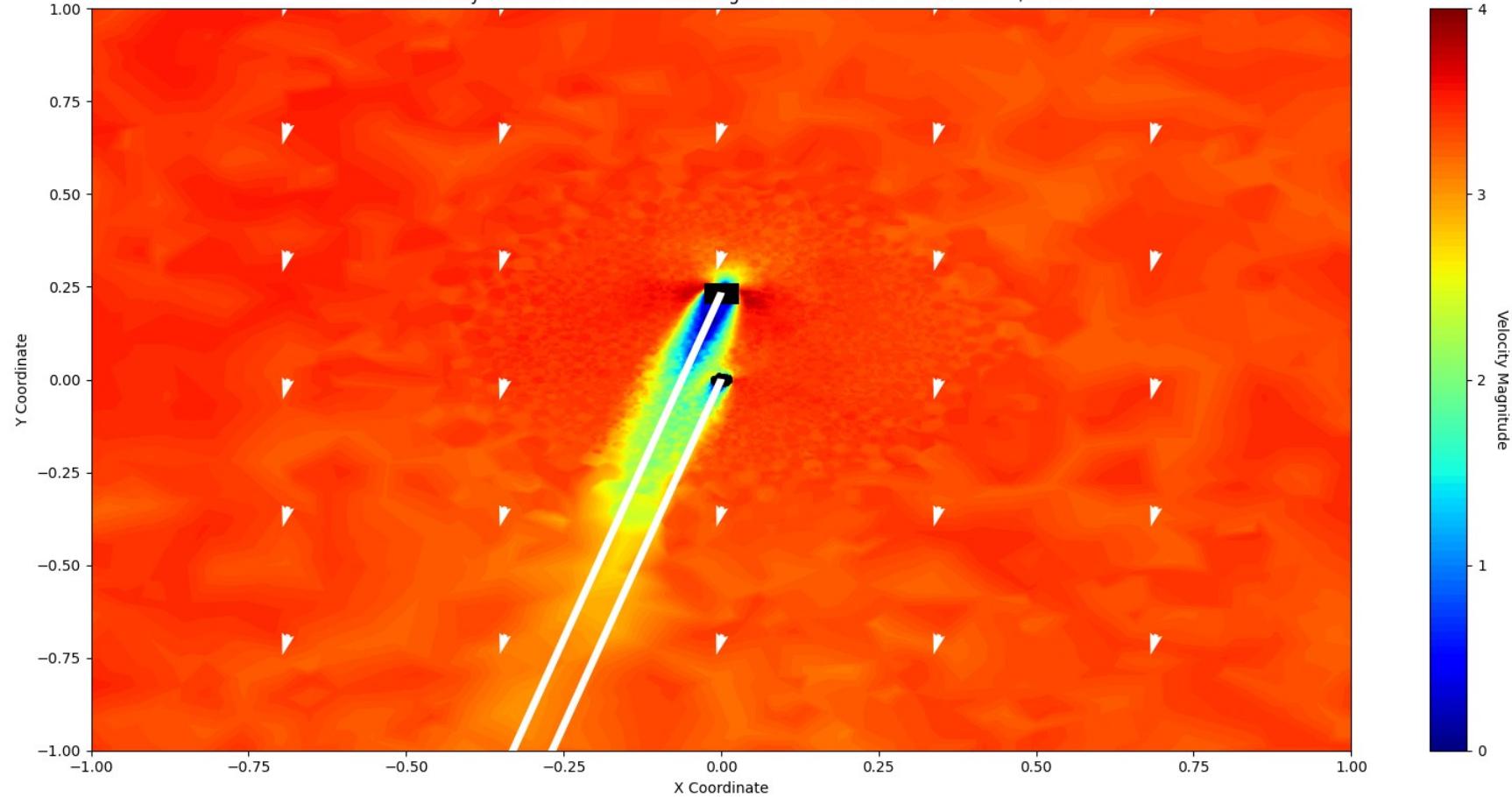
Threshold = 1E-5 (1030 Epochs, not completed), GPU Laptop

Scripts v4 – Plotting Any Angle

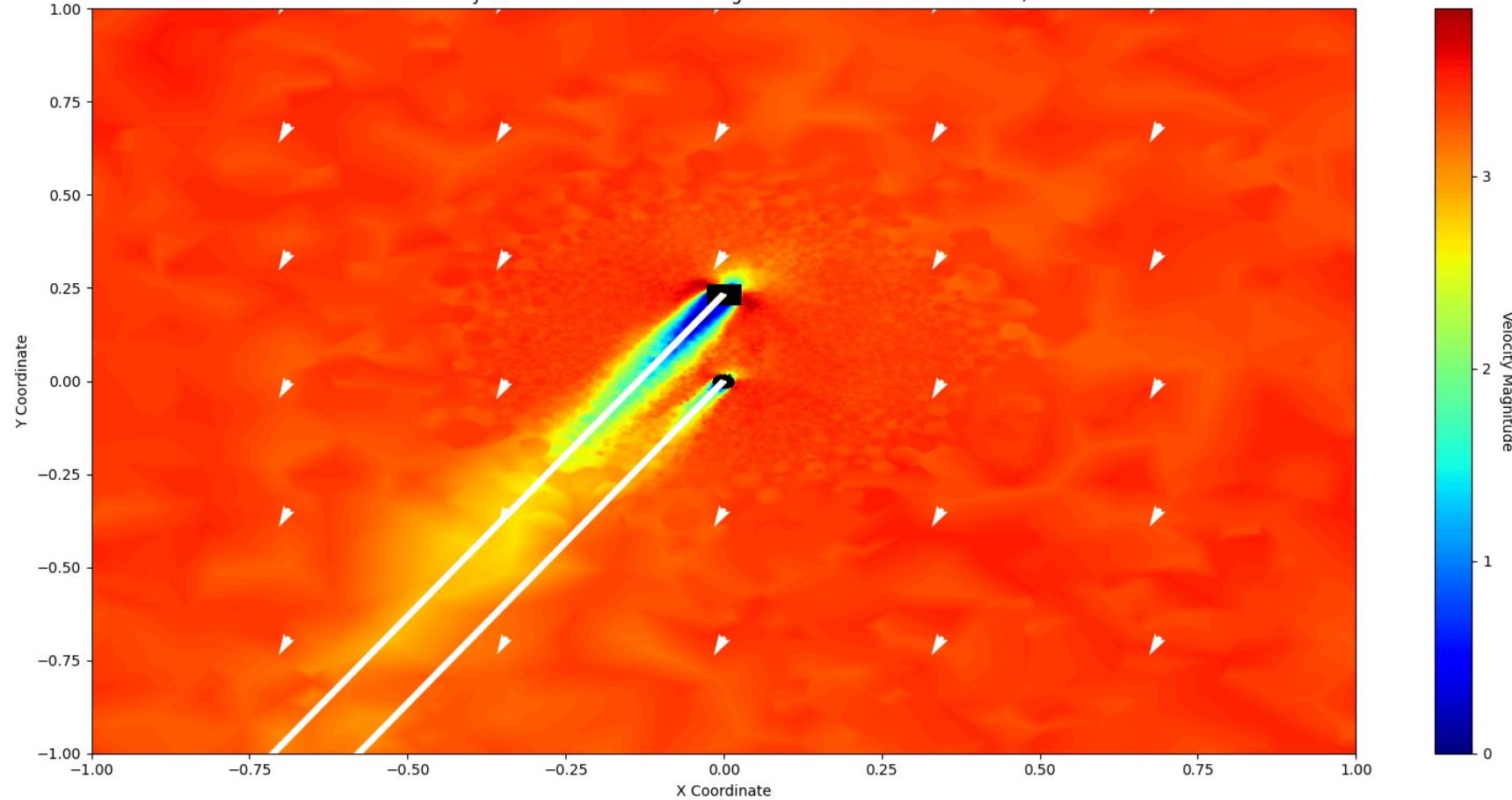
Total Velocity in the X-Y Plane for Wind Angle = 0 with a cut at Z = 0.17 +/- 0.02



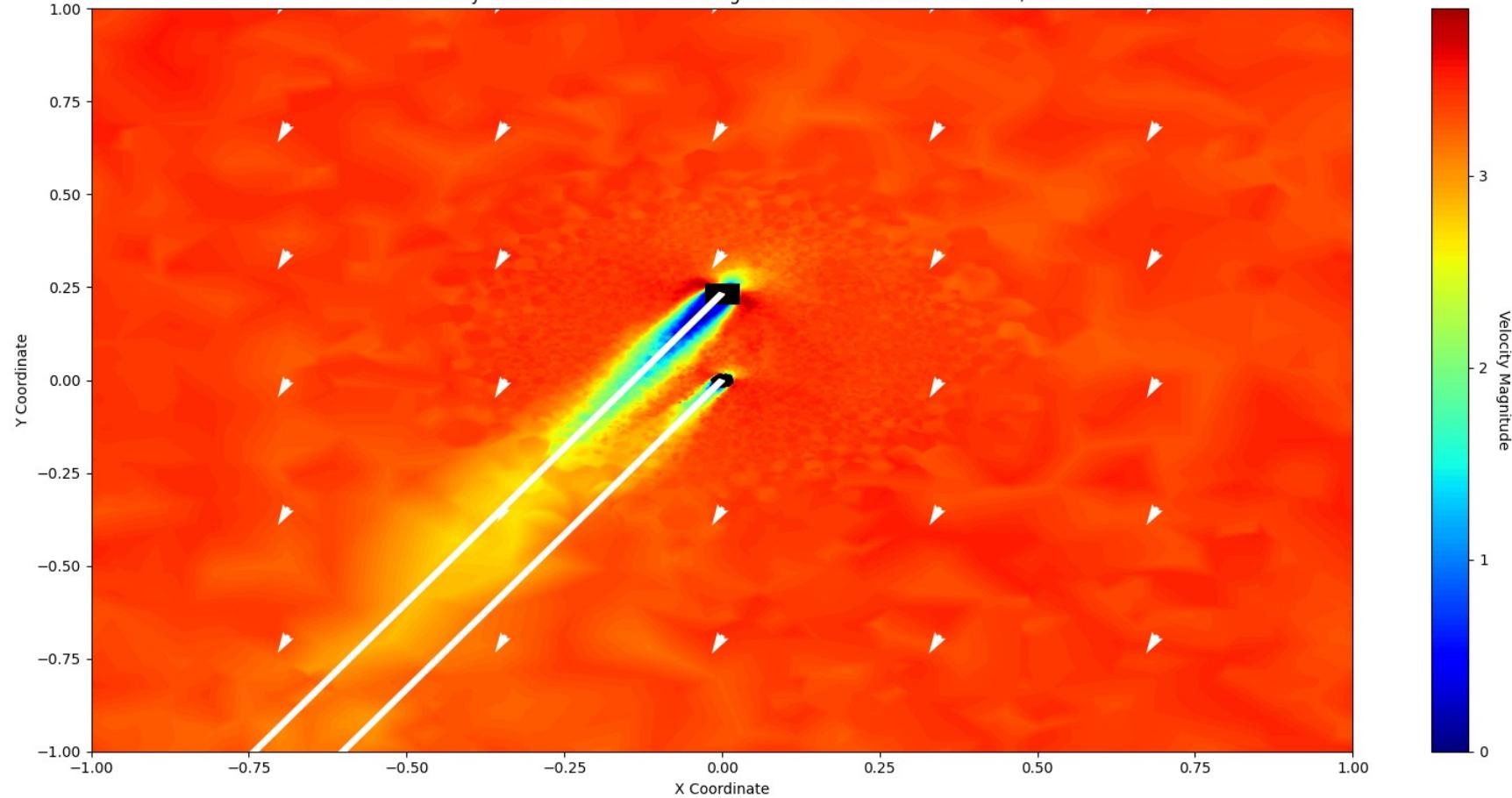
Total Velocity in the X-Y Plane for Wind Angle = 15 with a cut at Z = 0.17 +/- 0.02



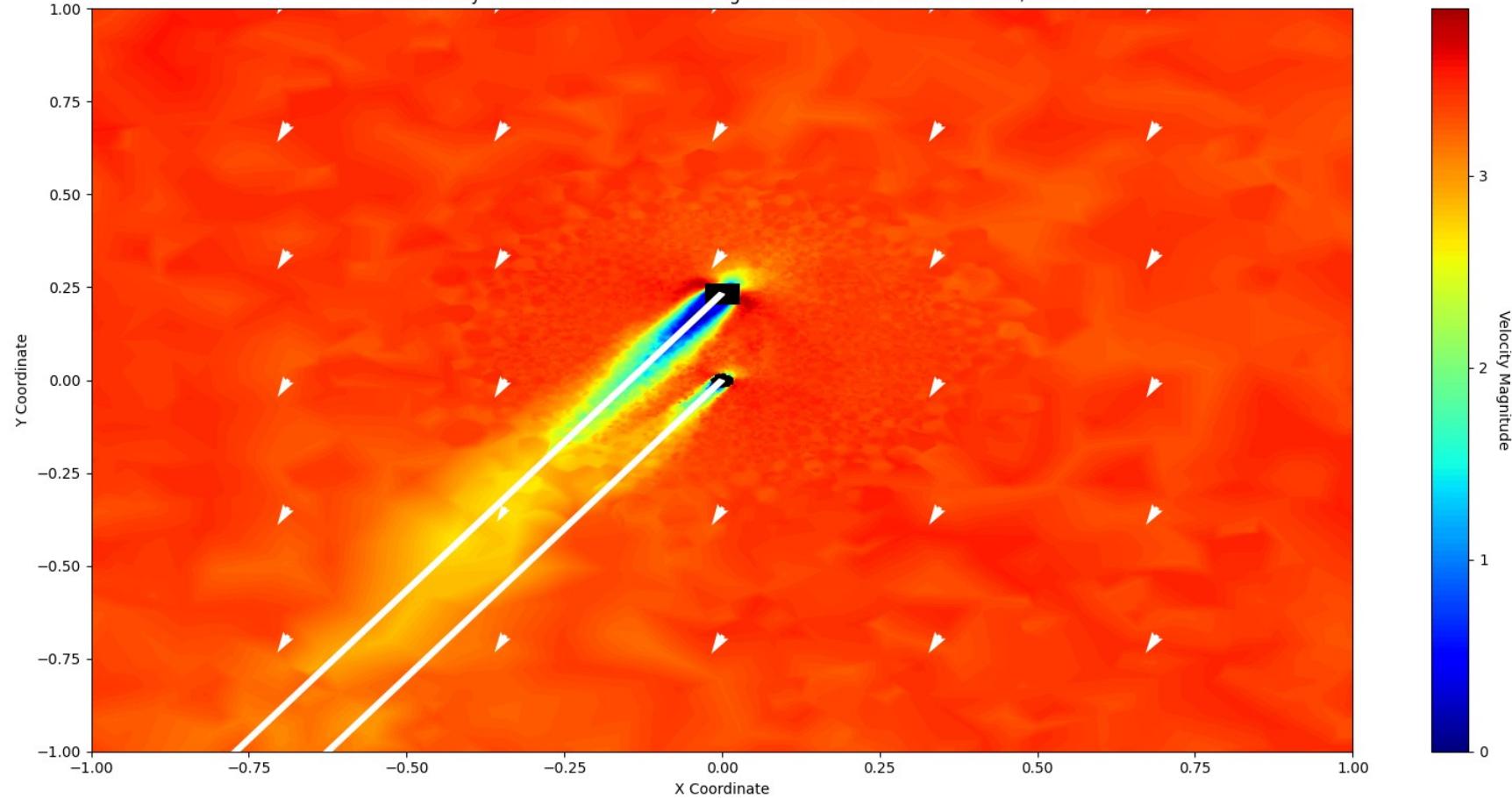
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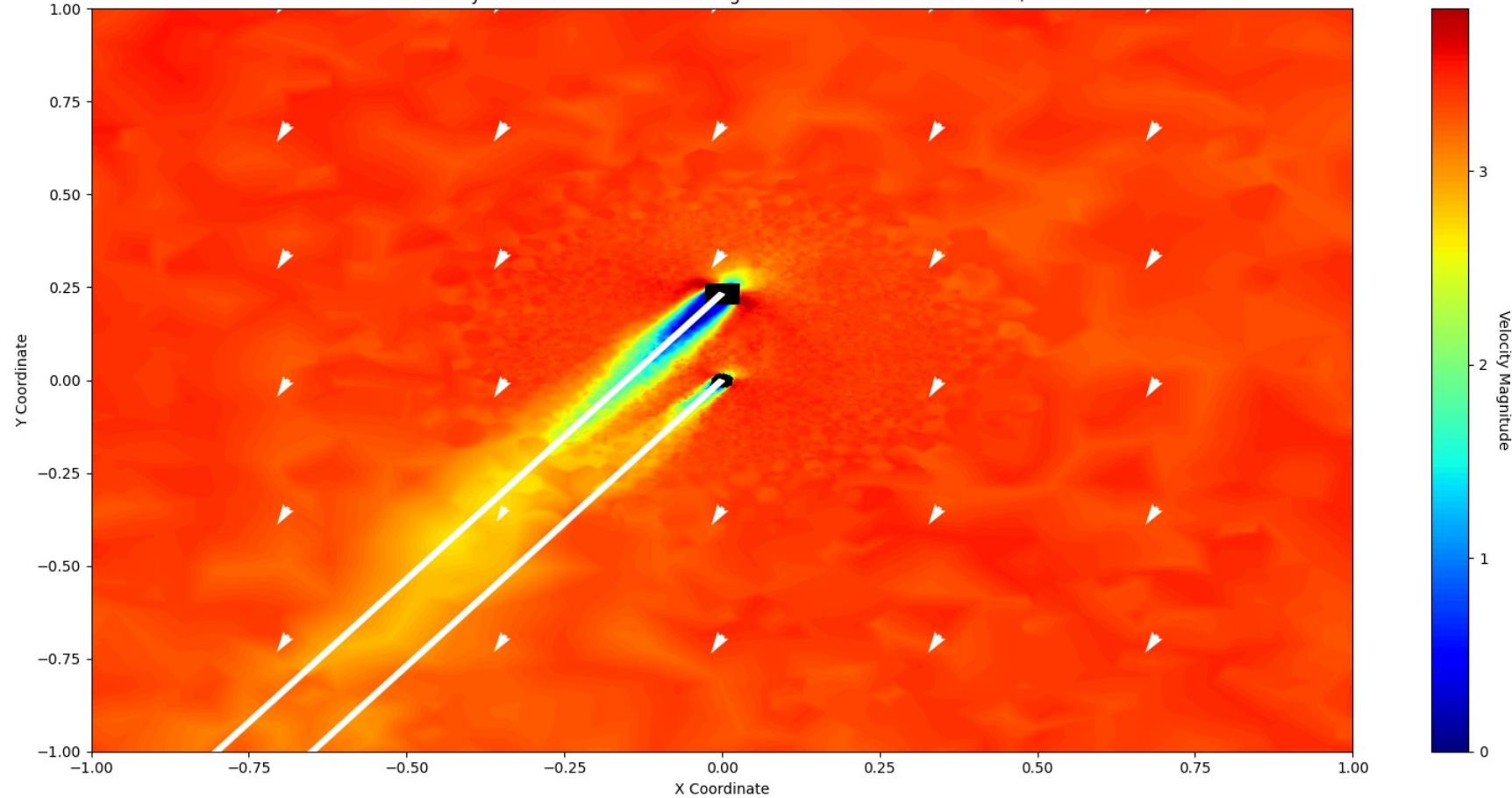
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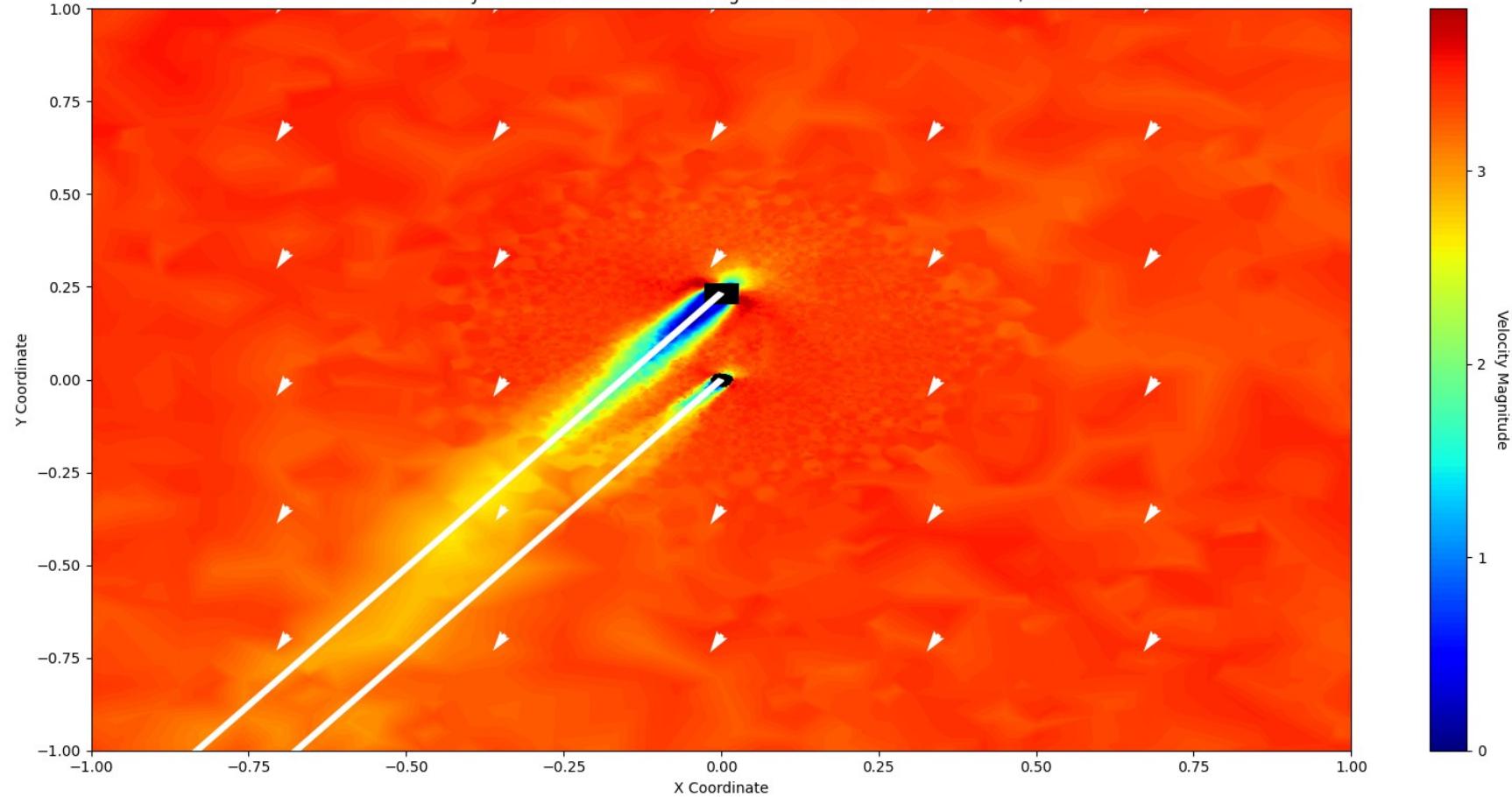
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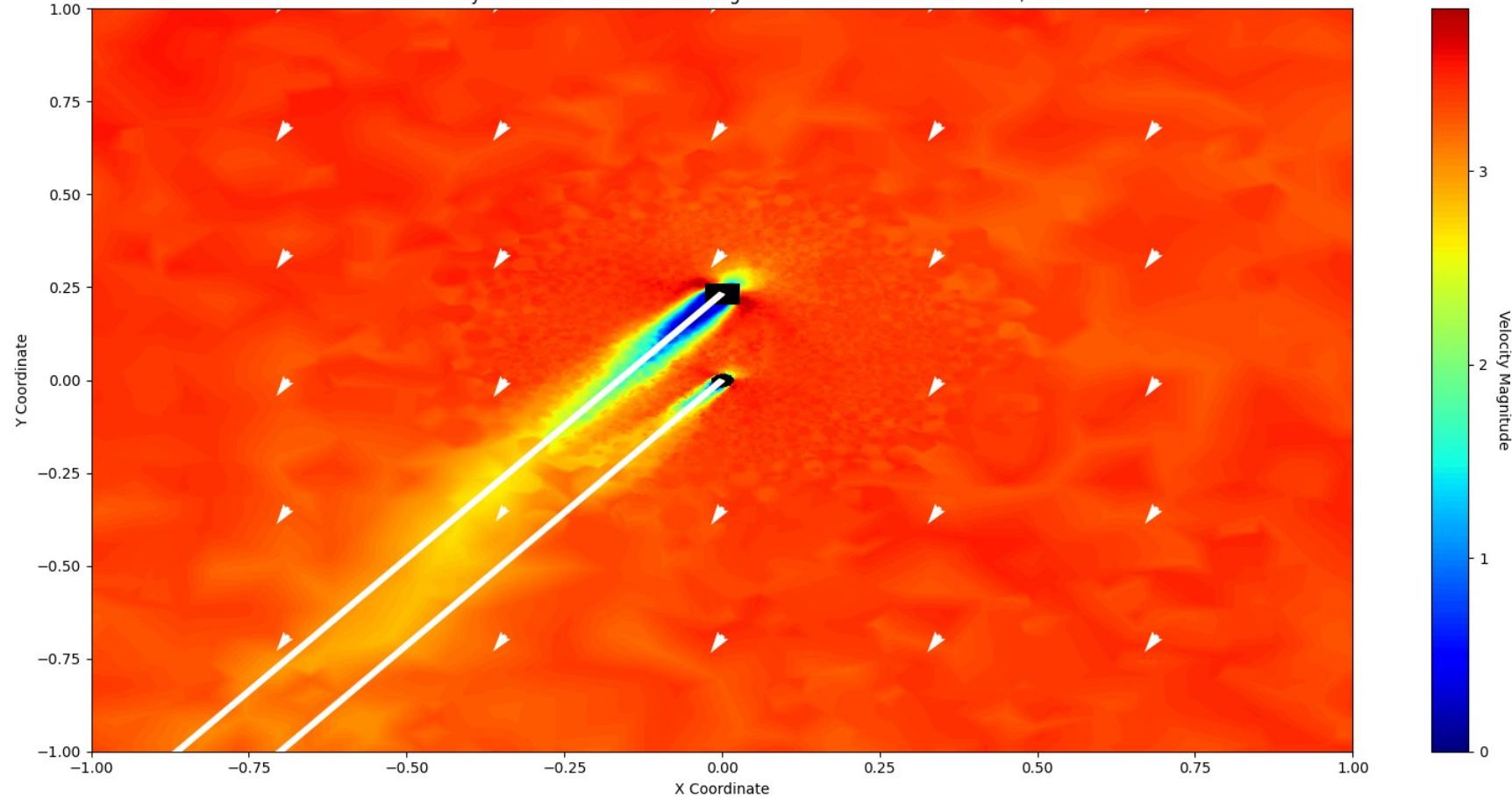
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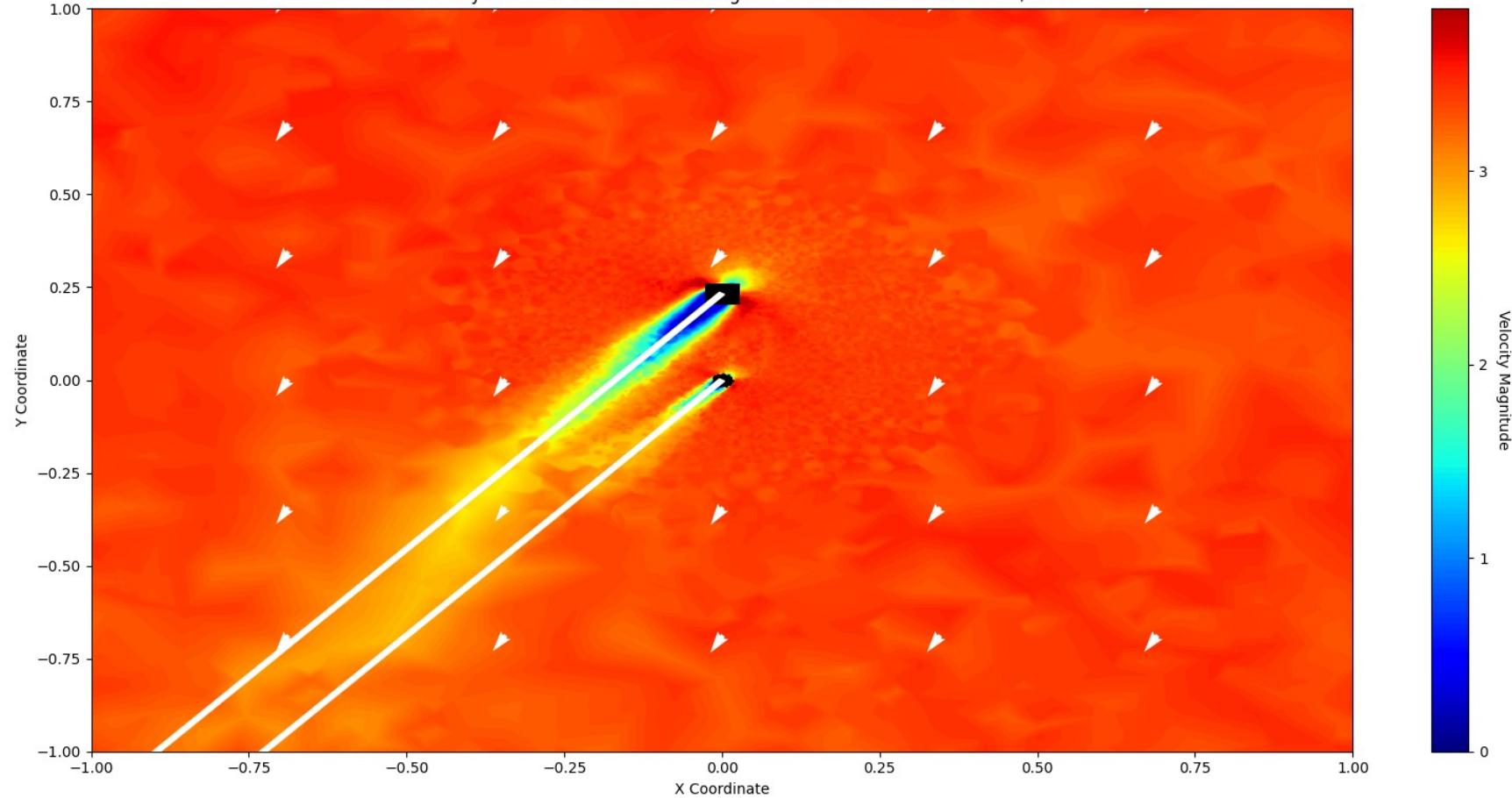
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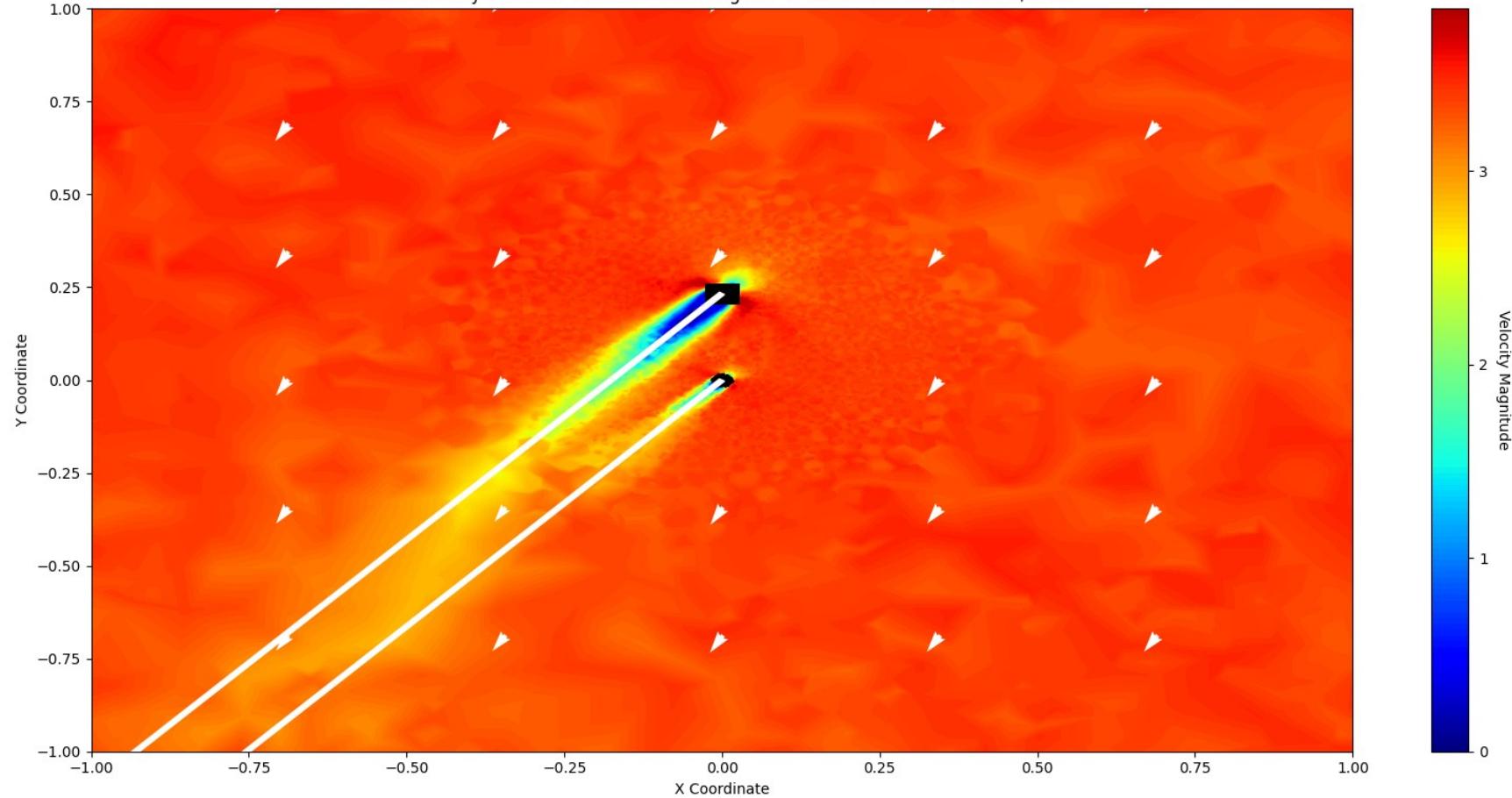
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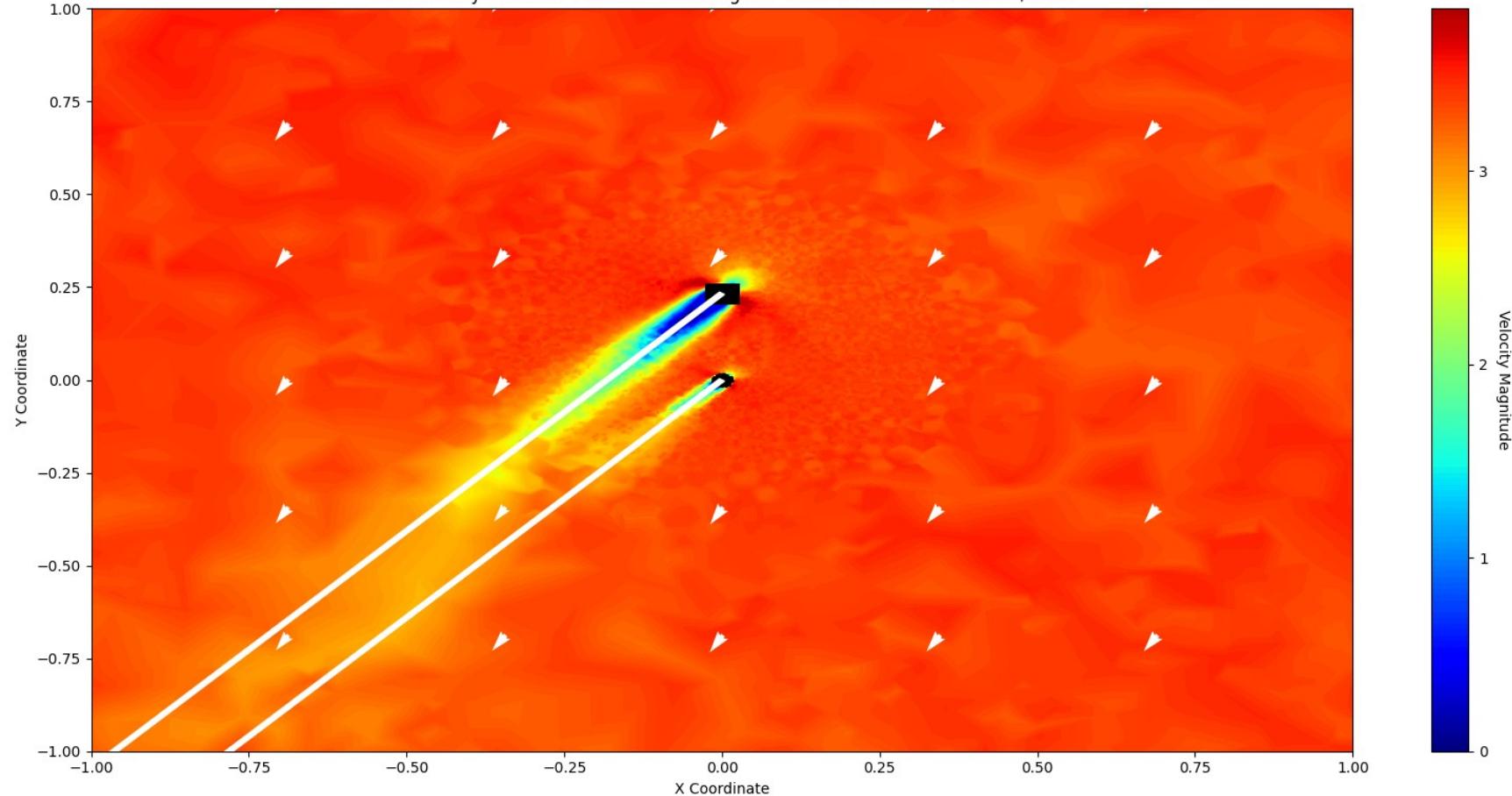
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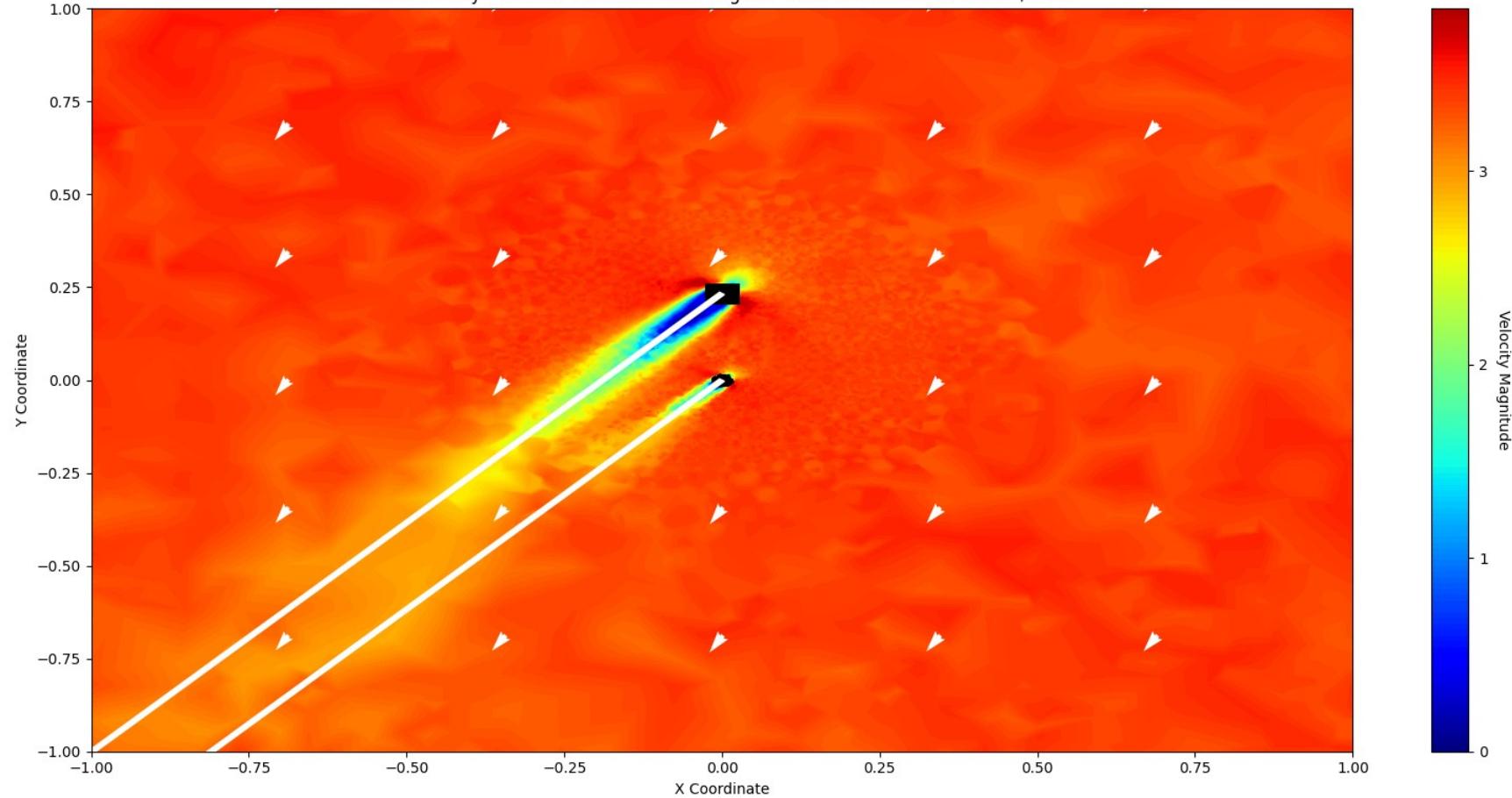
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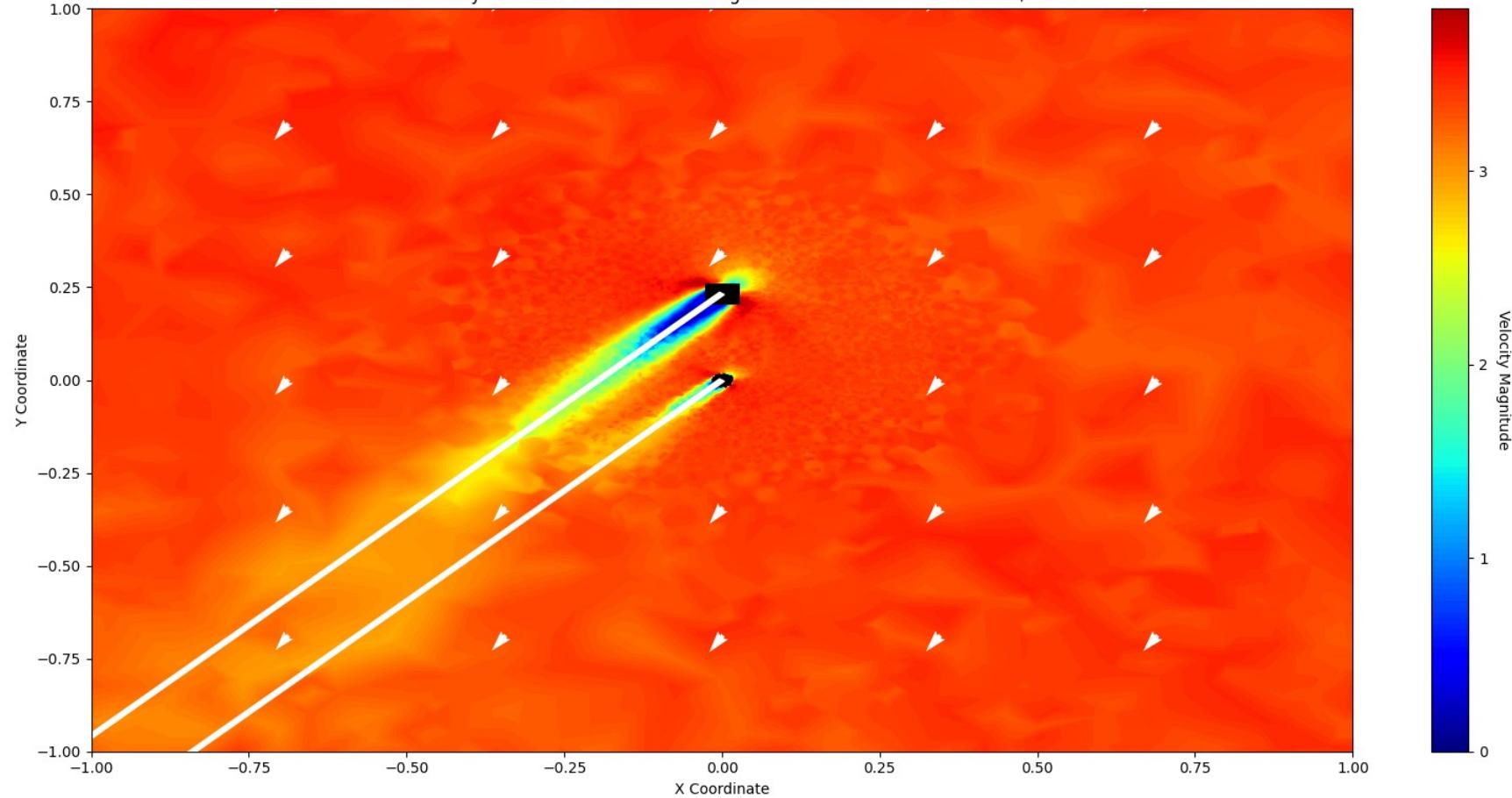
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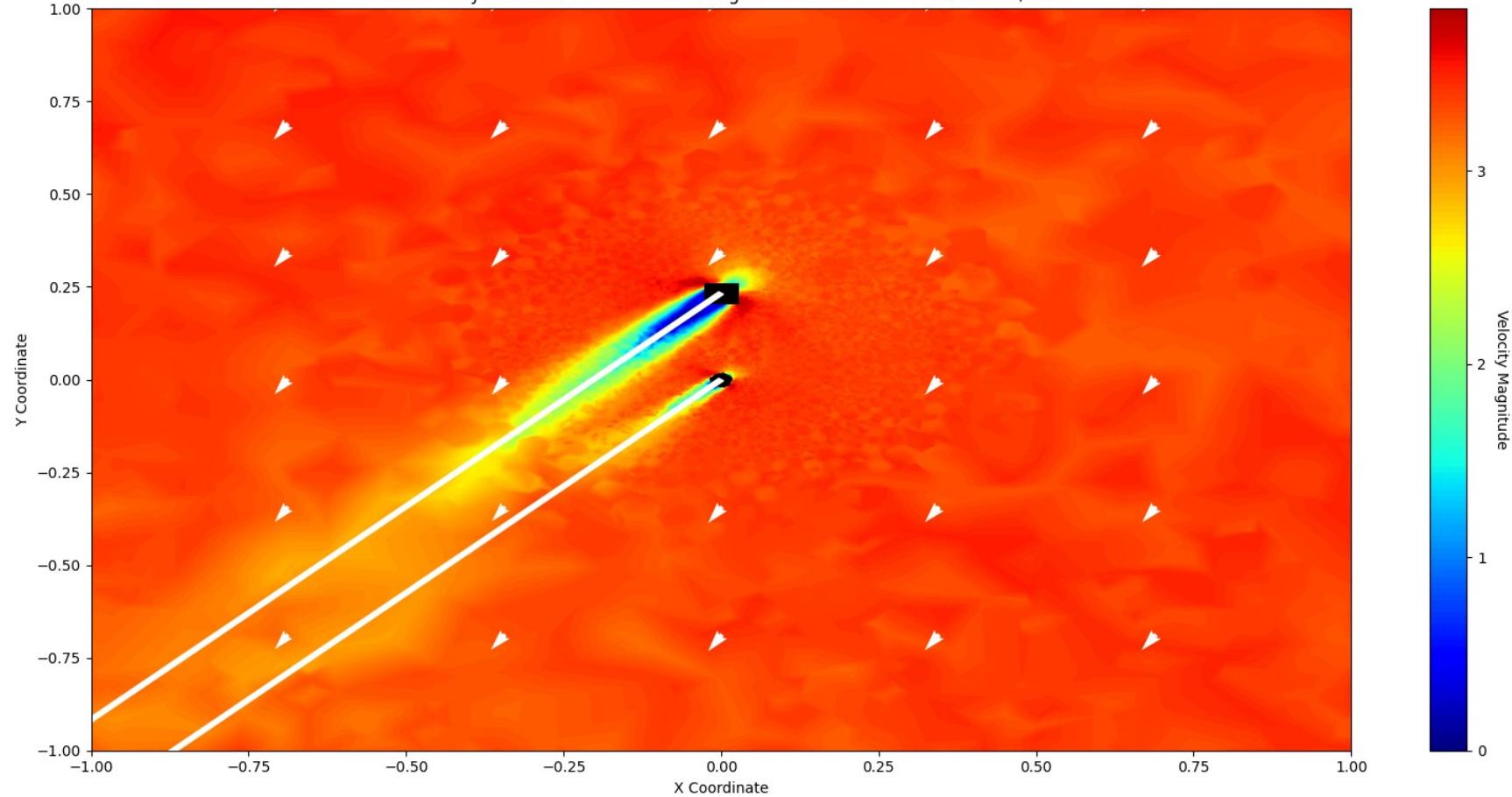
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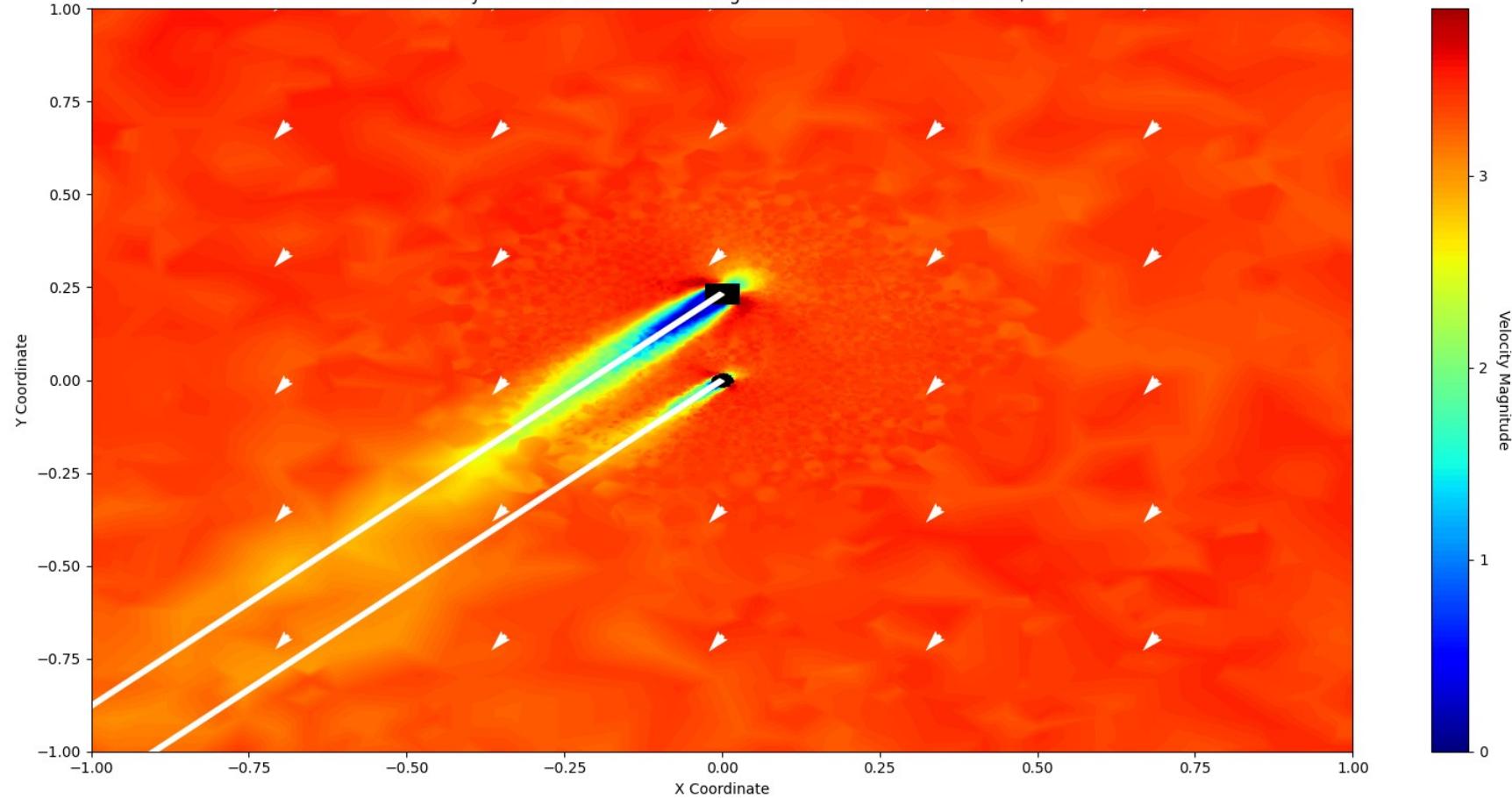
Total Velocity in the X-Y Plane for Wind Angle = 40 with a cut at Z = 0.17 +/- 0.02



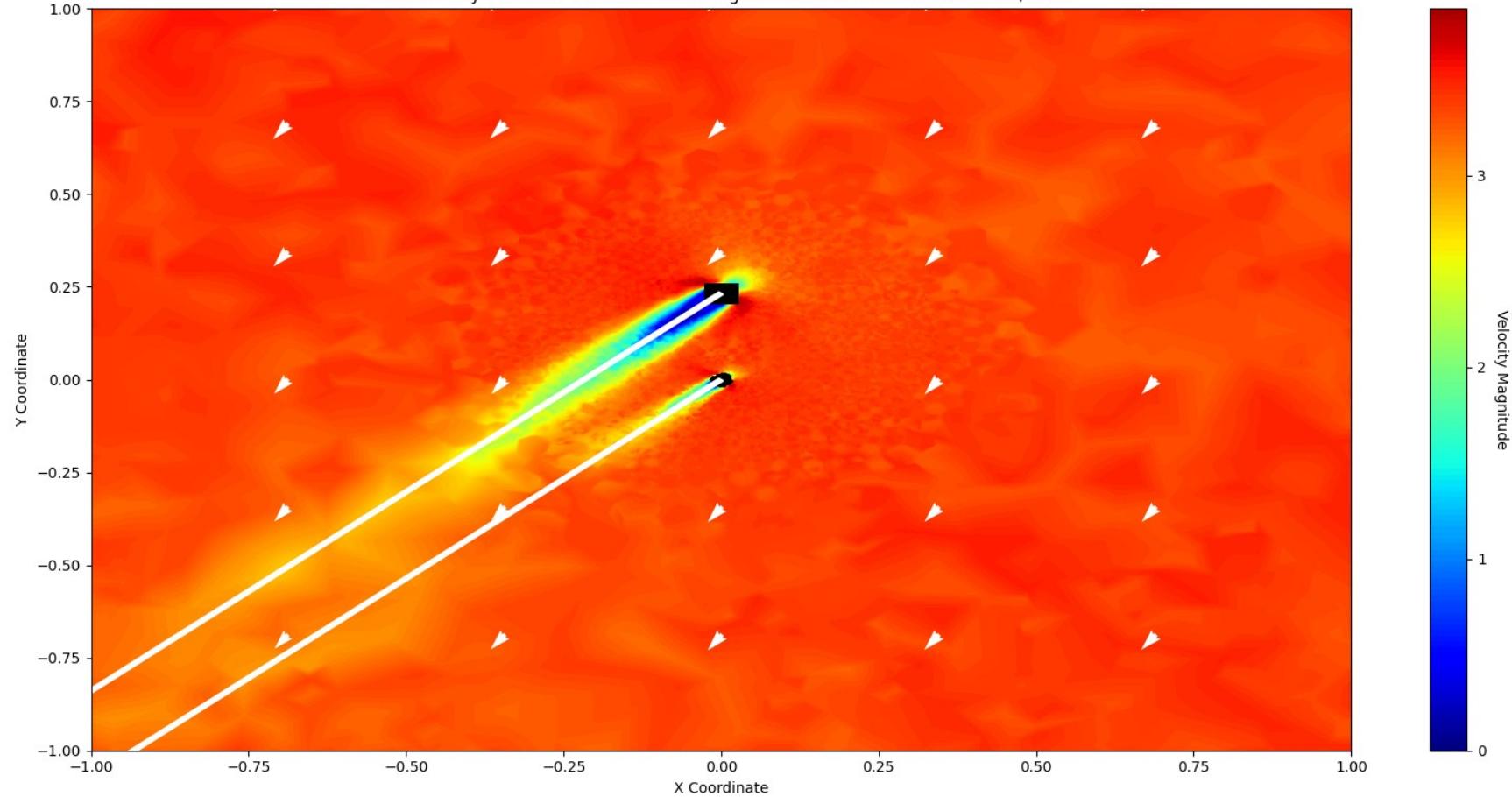
Total Velocity in the X-Y Plane for Wind Angle = 41 with a cut at Z = 0.17 +/- 0.02



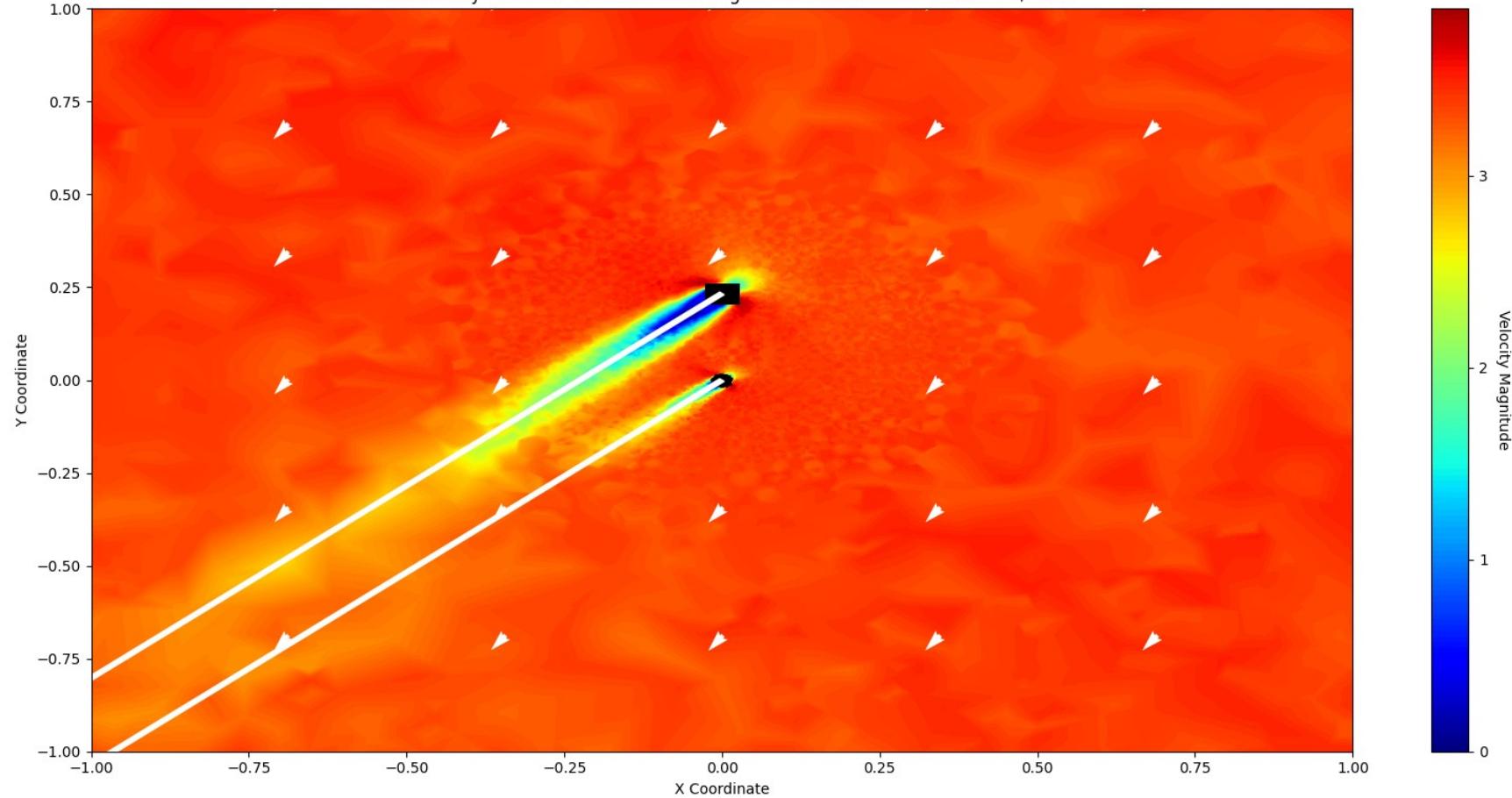
Total Velocity in the X-Y Plane for Wind Angle = 42 with a cut at Z = 0.17 +/- 0.02



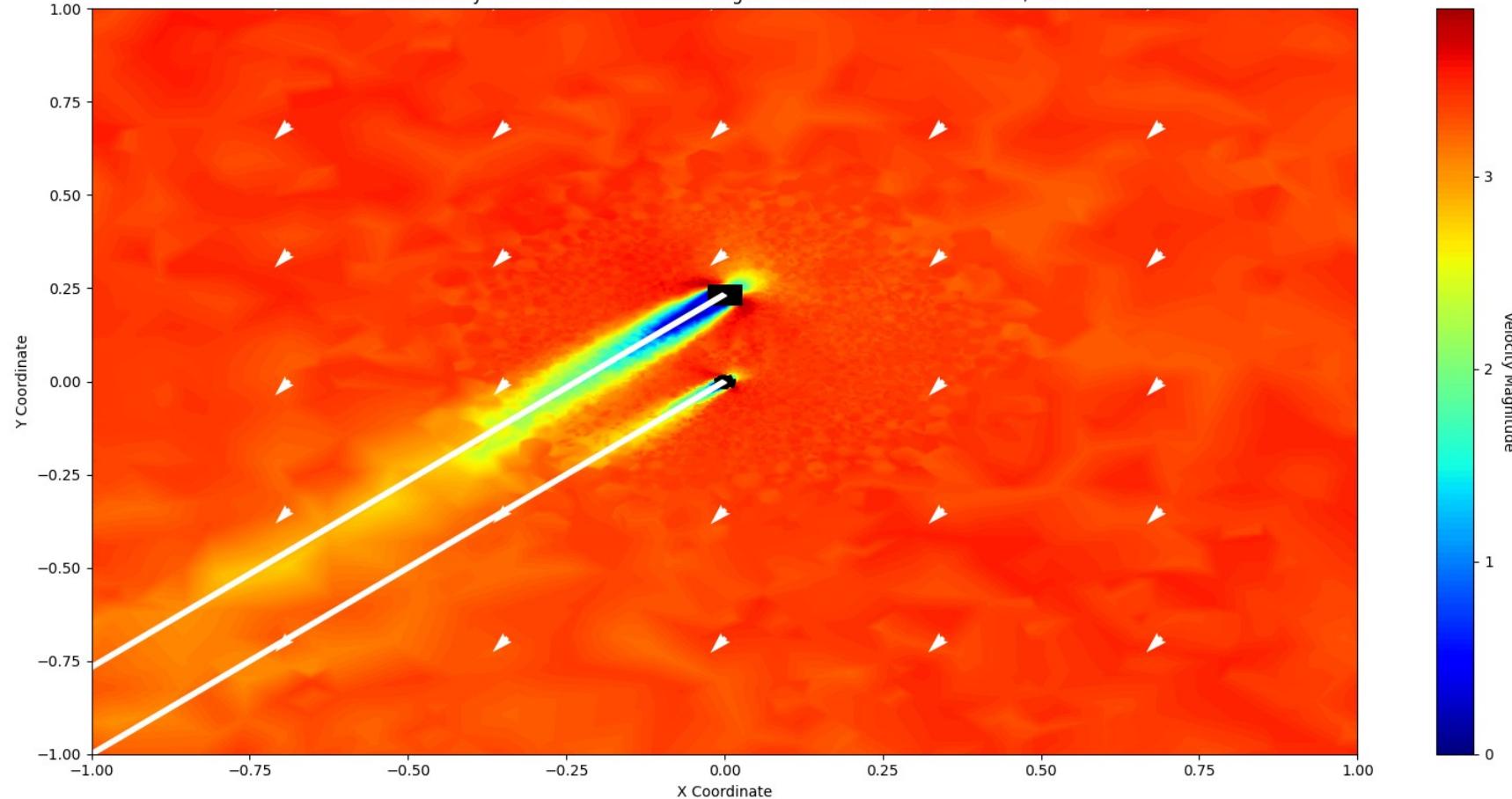
Total Velocity in the X-Y Plane for Wind Angle = 43 with a cut at Z = 0.17 +/- 0.02



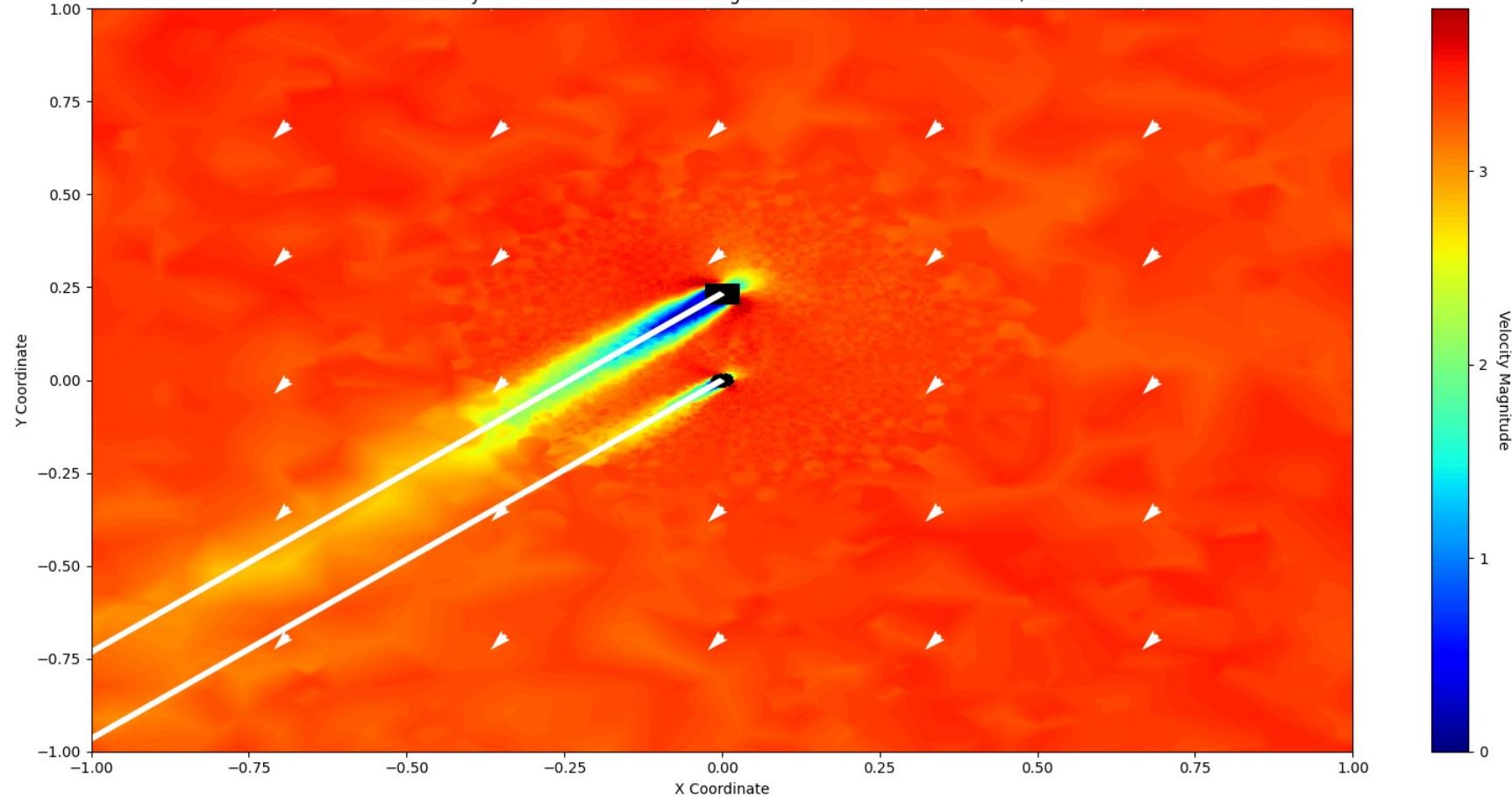
Total Velocity in the X-Y Plane for Wind Angle = 44 with a cut at Z = 0.17 +/- 0.02



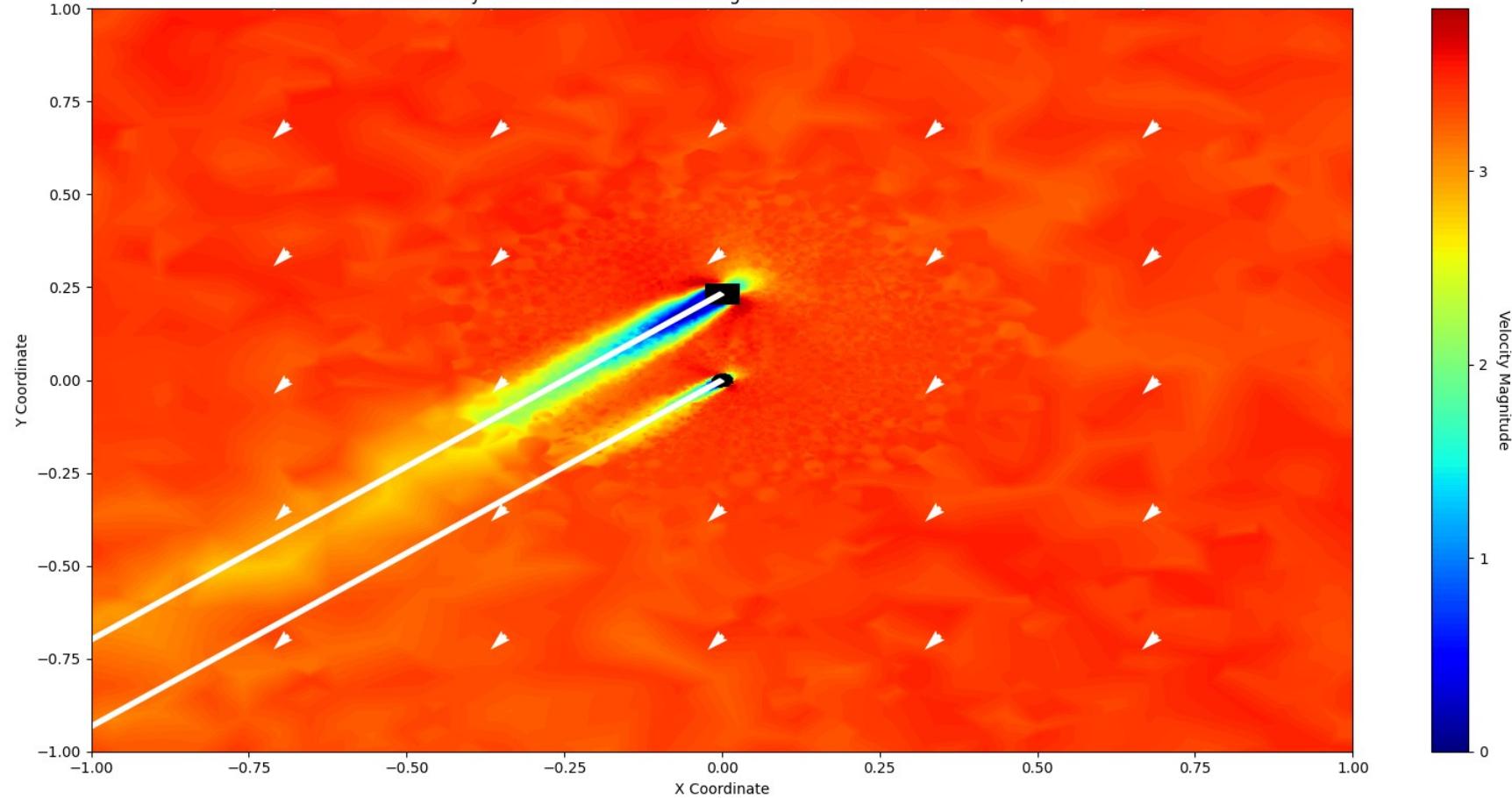
Total Velocity in the X-Y Plane for Wind Angle = 45 with a cut at Z = 0.17 +/- 0.02



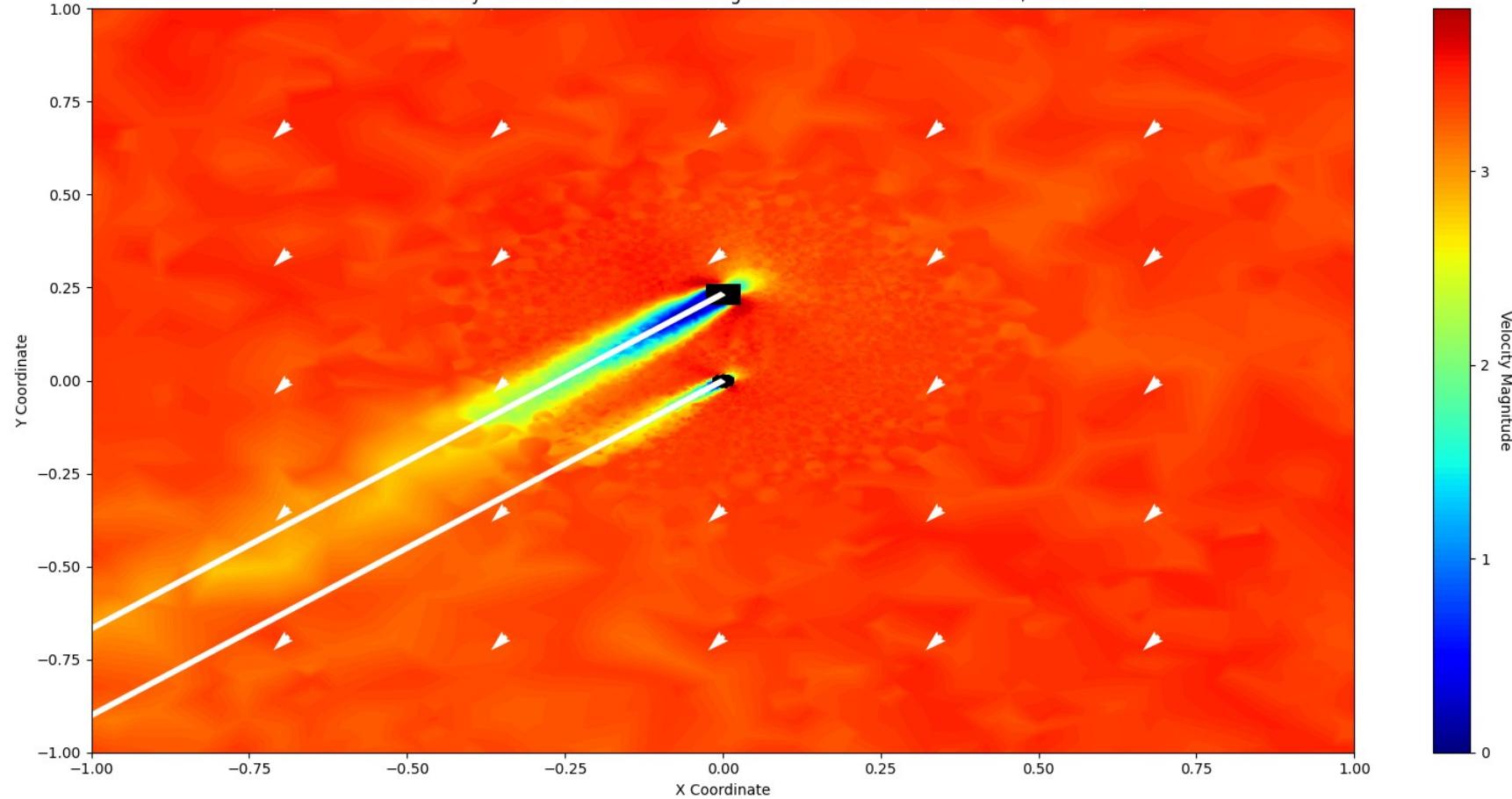
Total Velocity in the X-Y Plane for Wind Angle = 46 with a cut at Z = 0.17 +/- 0.02



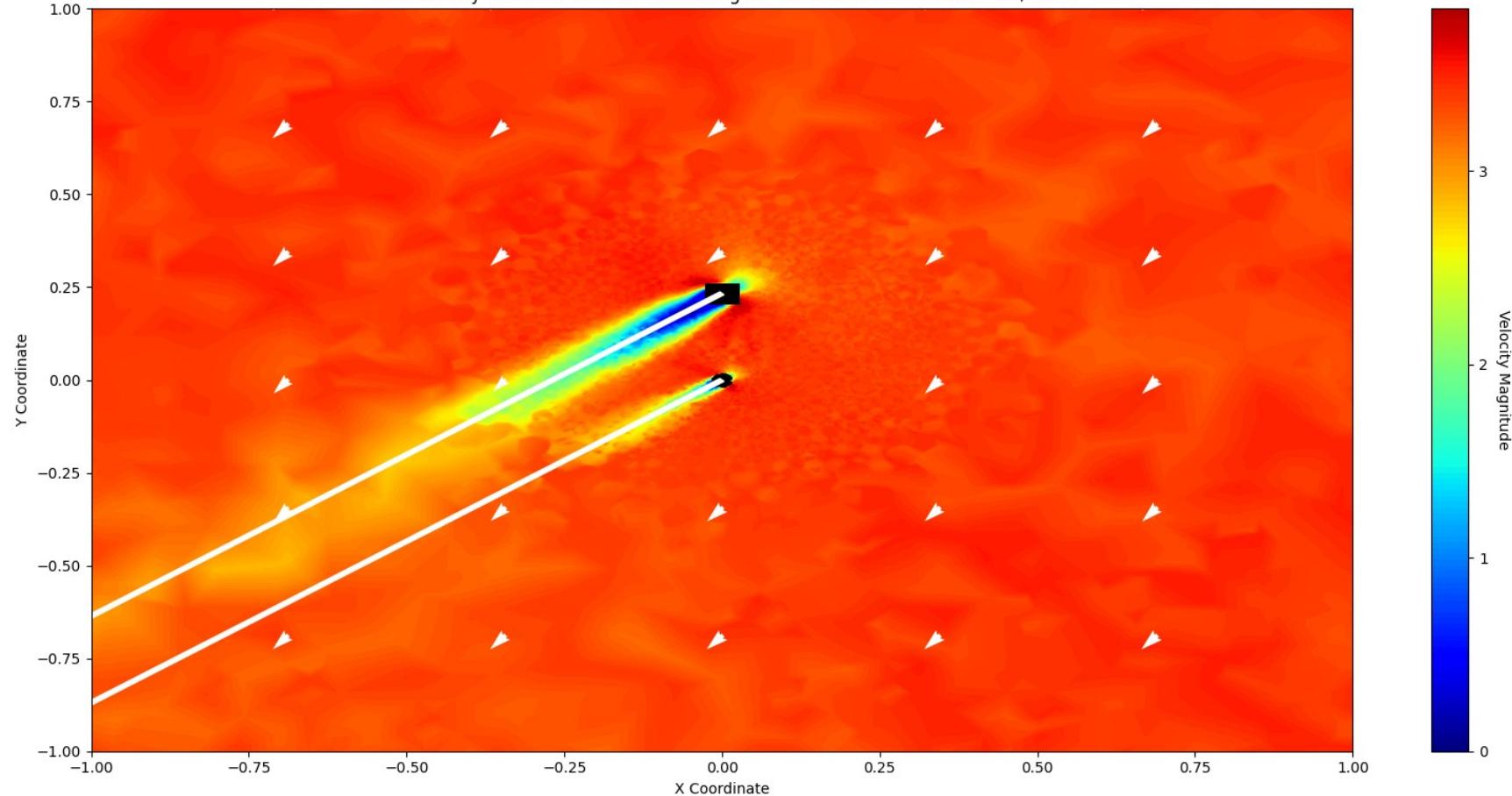
Total Velocity in the X-Y Plane for Wind Angle = 47 with a cut at Z = 0.17 +/- 0.02



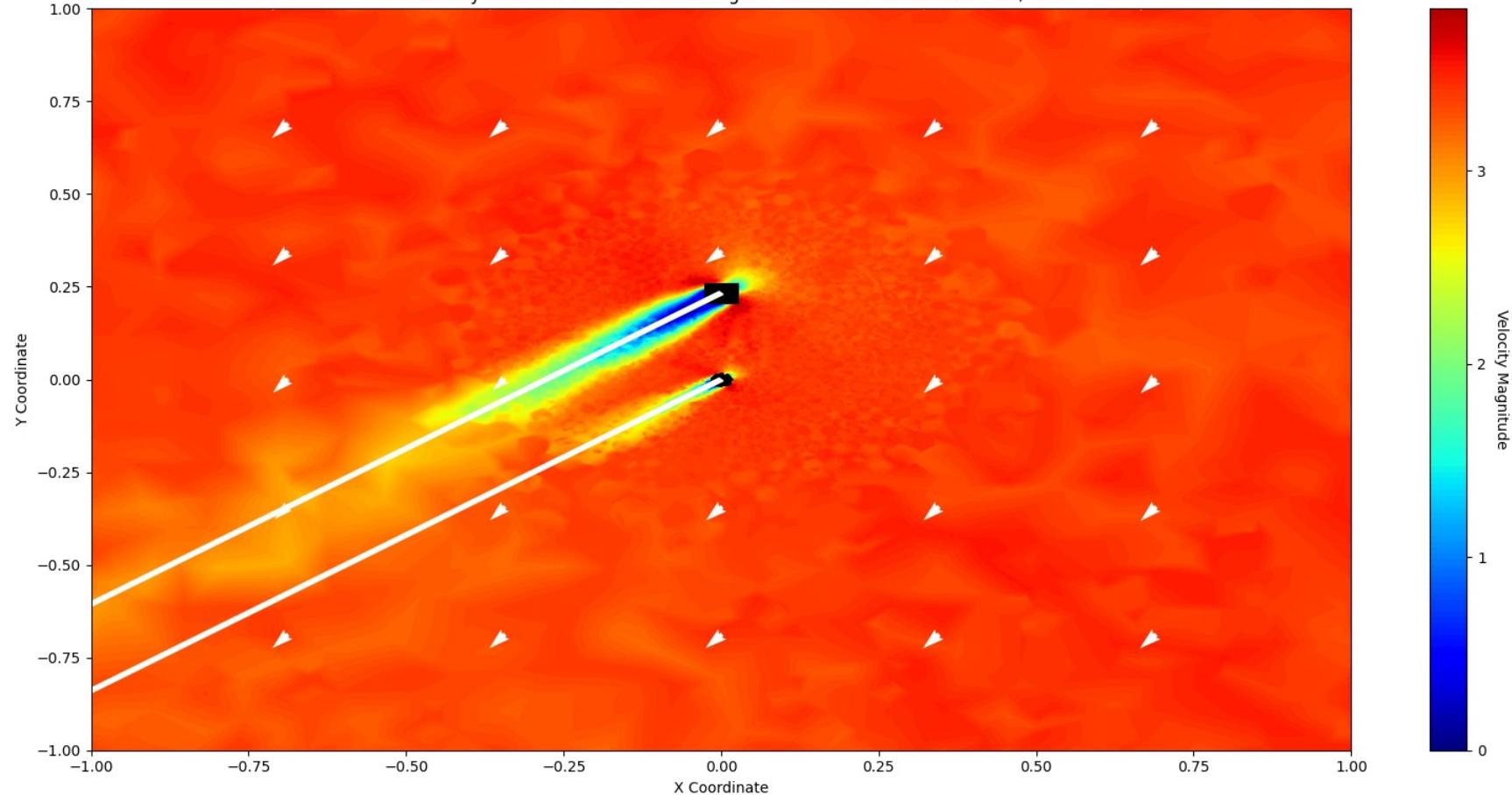
Total Velocity in the X-Y Plane for Wind Angle = 48 with a cut at Z = 0.17 +/- 0.02



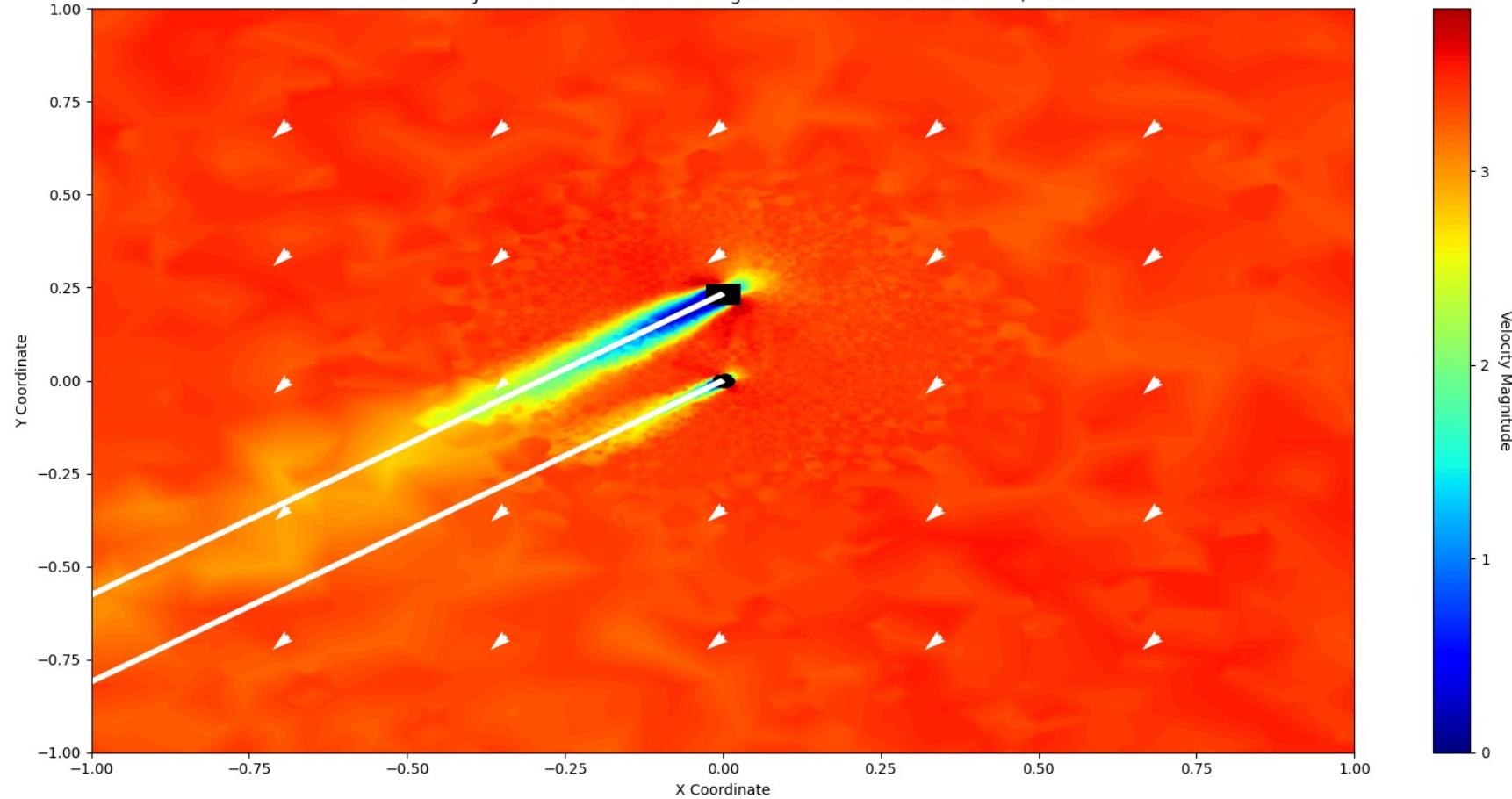
Total Velocity in the X-Y Plane for Wind Angle = 49 with a cut at Z = 0.17 +/- 0.02



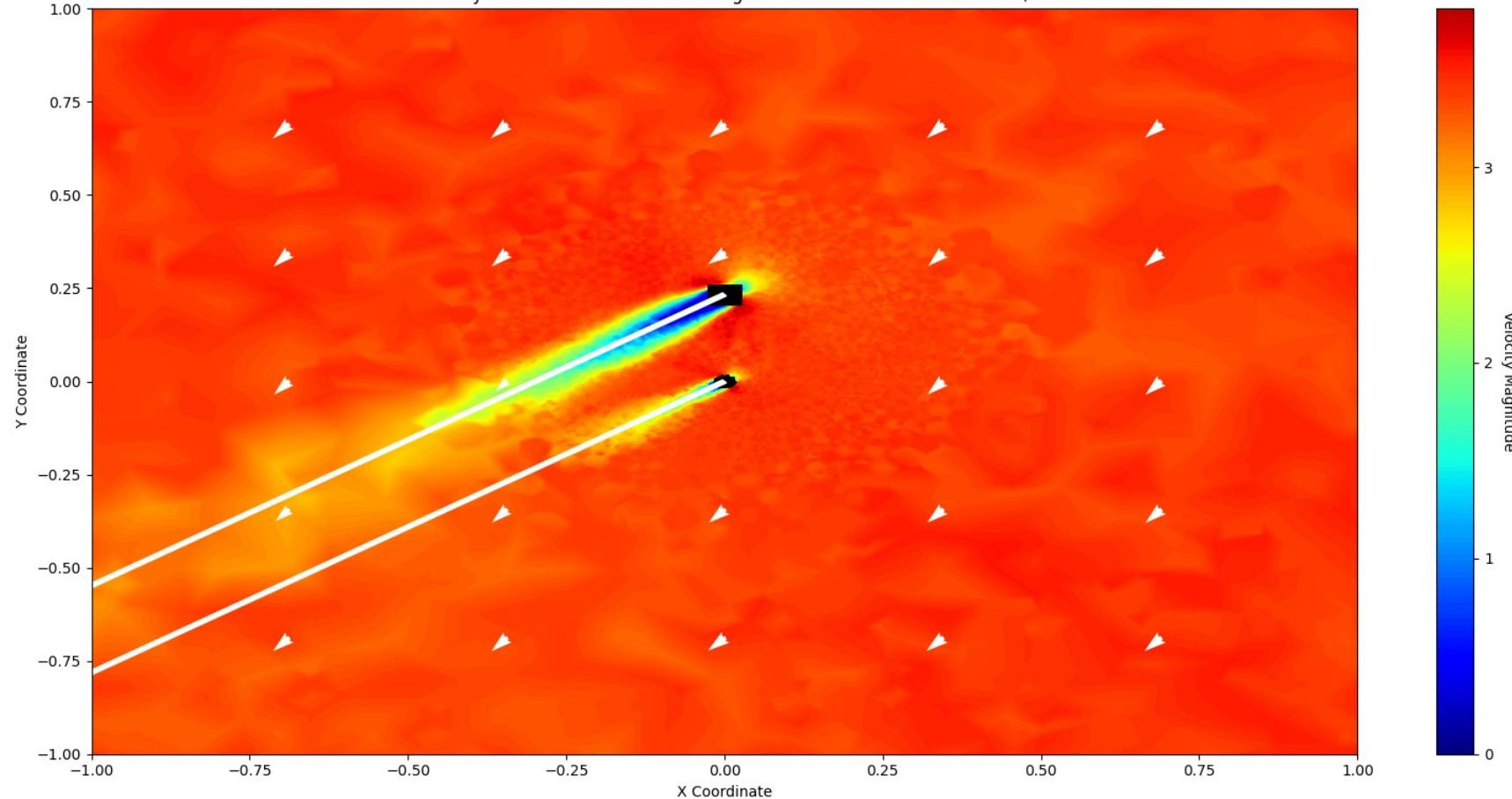
Total Velocity in the X-Y Plane for Wind Angle = 50 with a cut at Z = 0.17 +/- 0.02



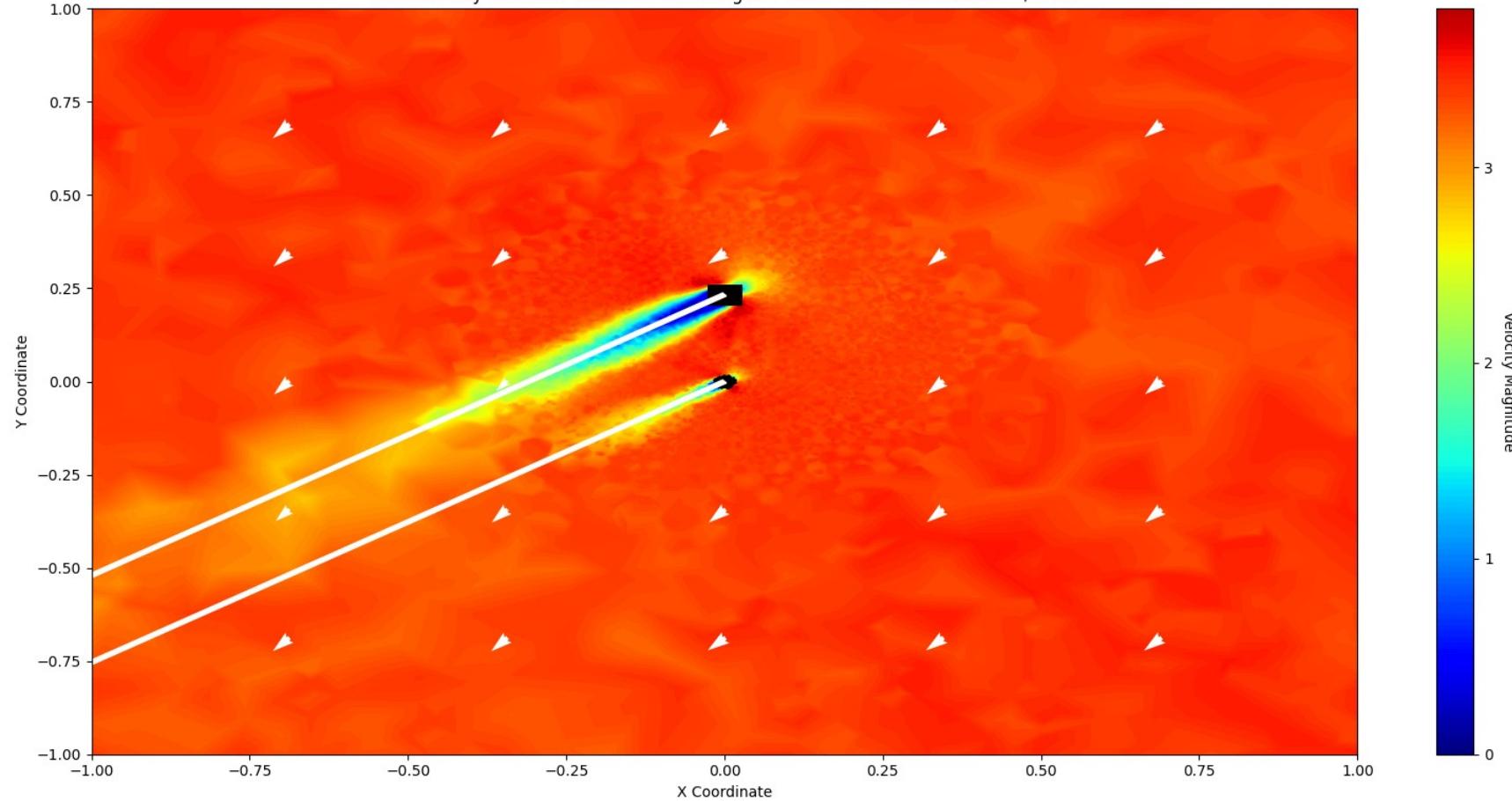
Total Velocity in the X-Y Plane for Wind Angle = 51 with a cut at Z = 0.17 +/- 0.02



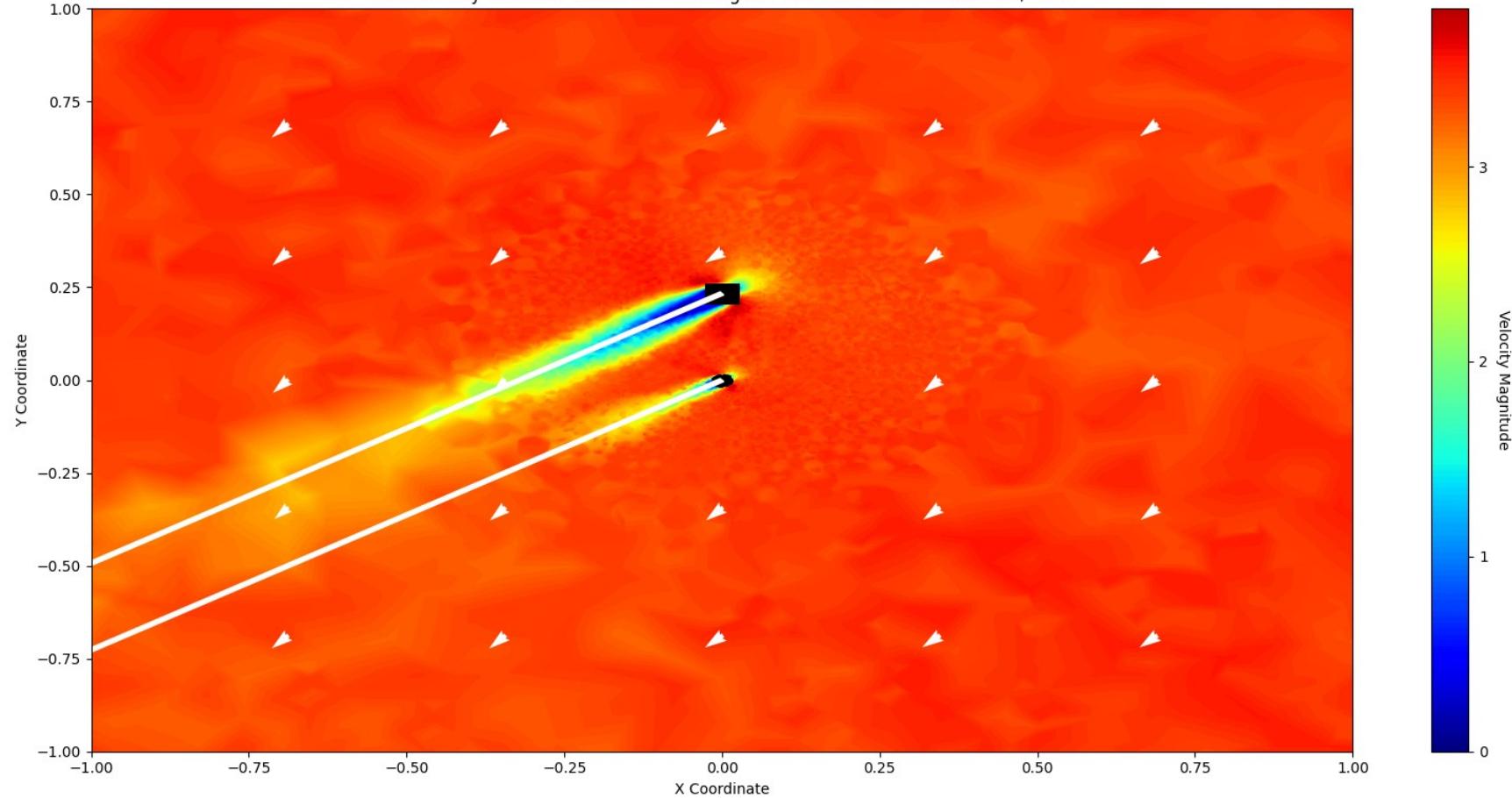
Total Velocity in the X-Y Plane for Wind Angle = 52 with a cut at Z = 0.17 +/- 0.02



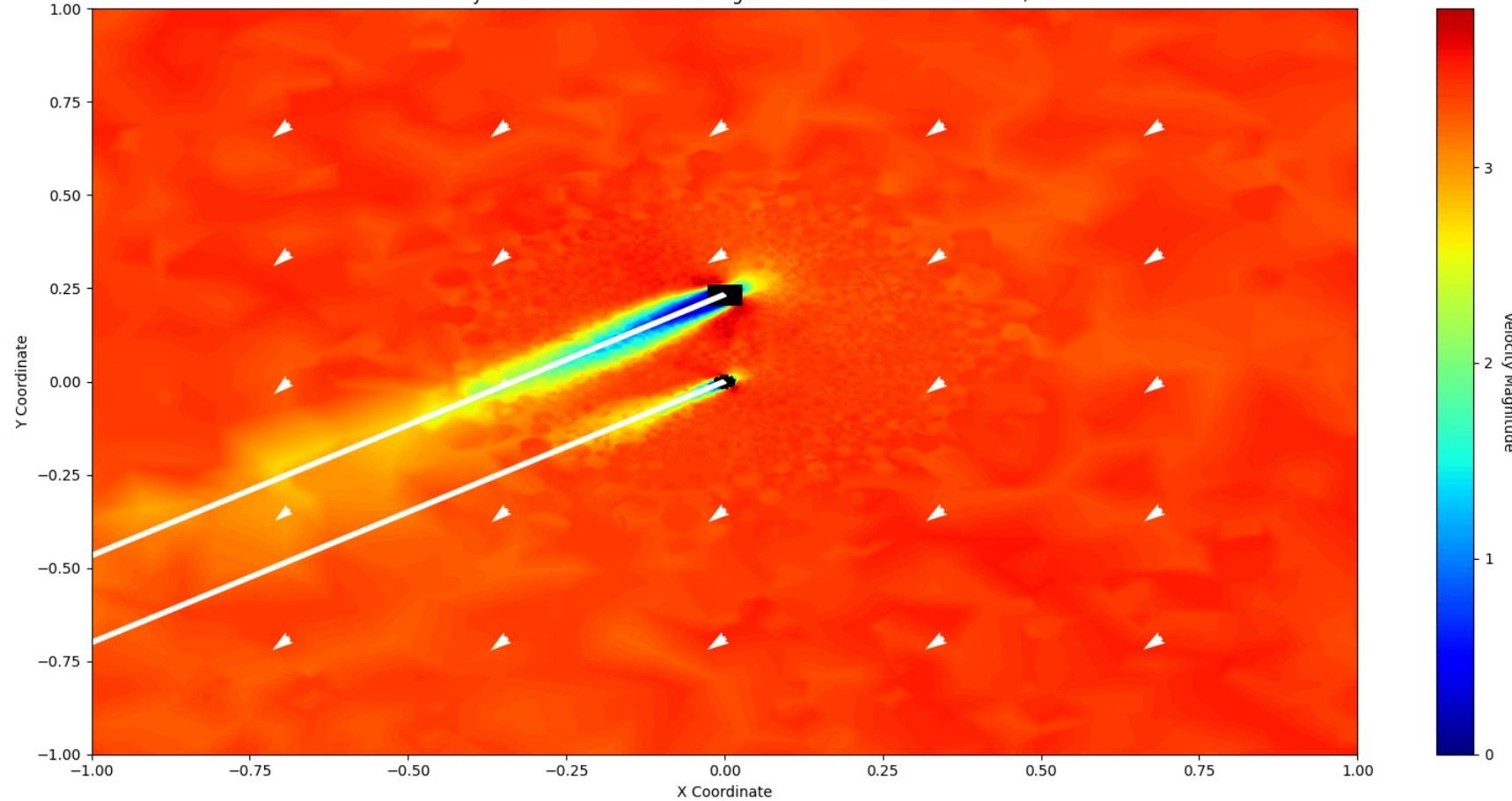
Total Velocity in the X-Y Plane for Wind Angle = 53 with a cut at Z = 0.17 +/- 0.02



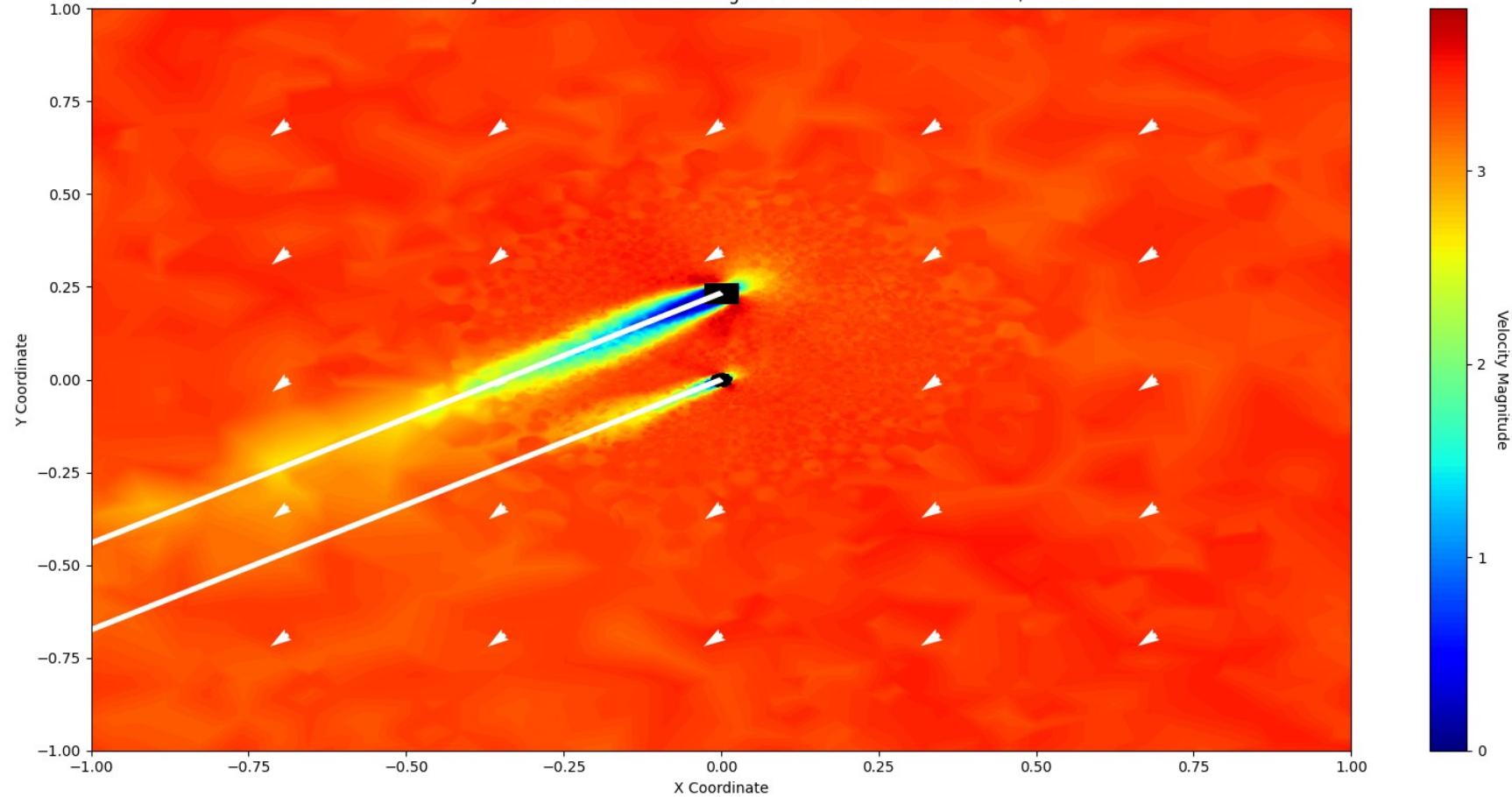
Total Velocity in the X-Y Plane for Wind Angle = 54 with a cut at Z = 0.17 +/- 0.02



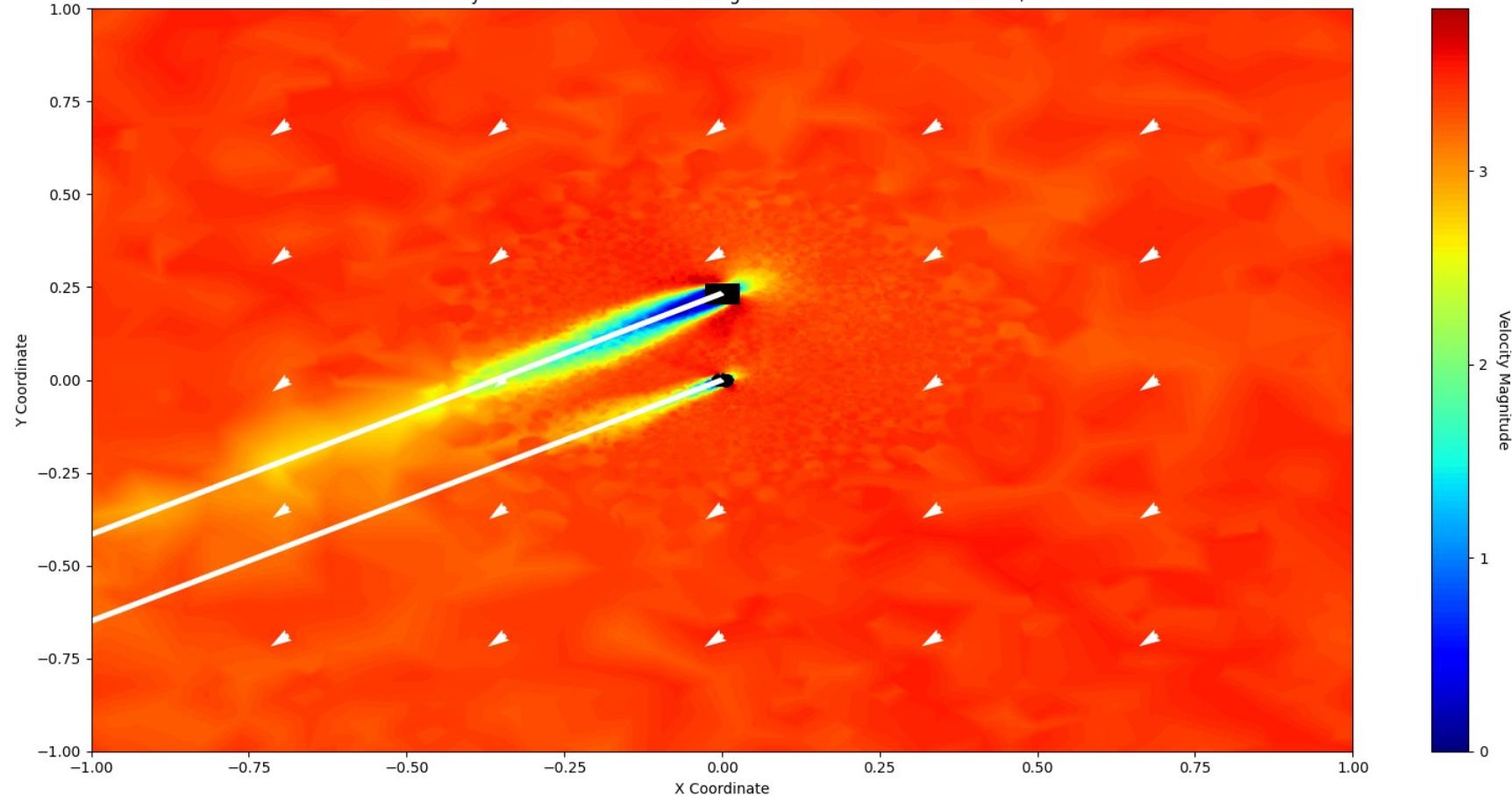
Total Velocity in the X-Y Plane for Wind Angle = 55 with a cut at Z = 0.17 +/- 0.02



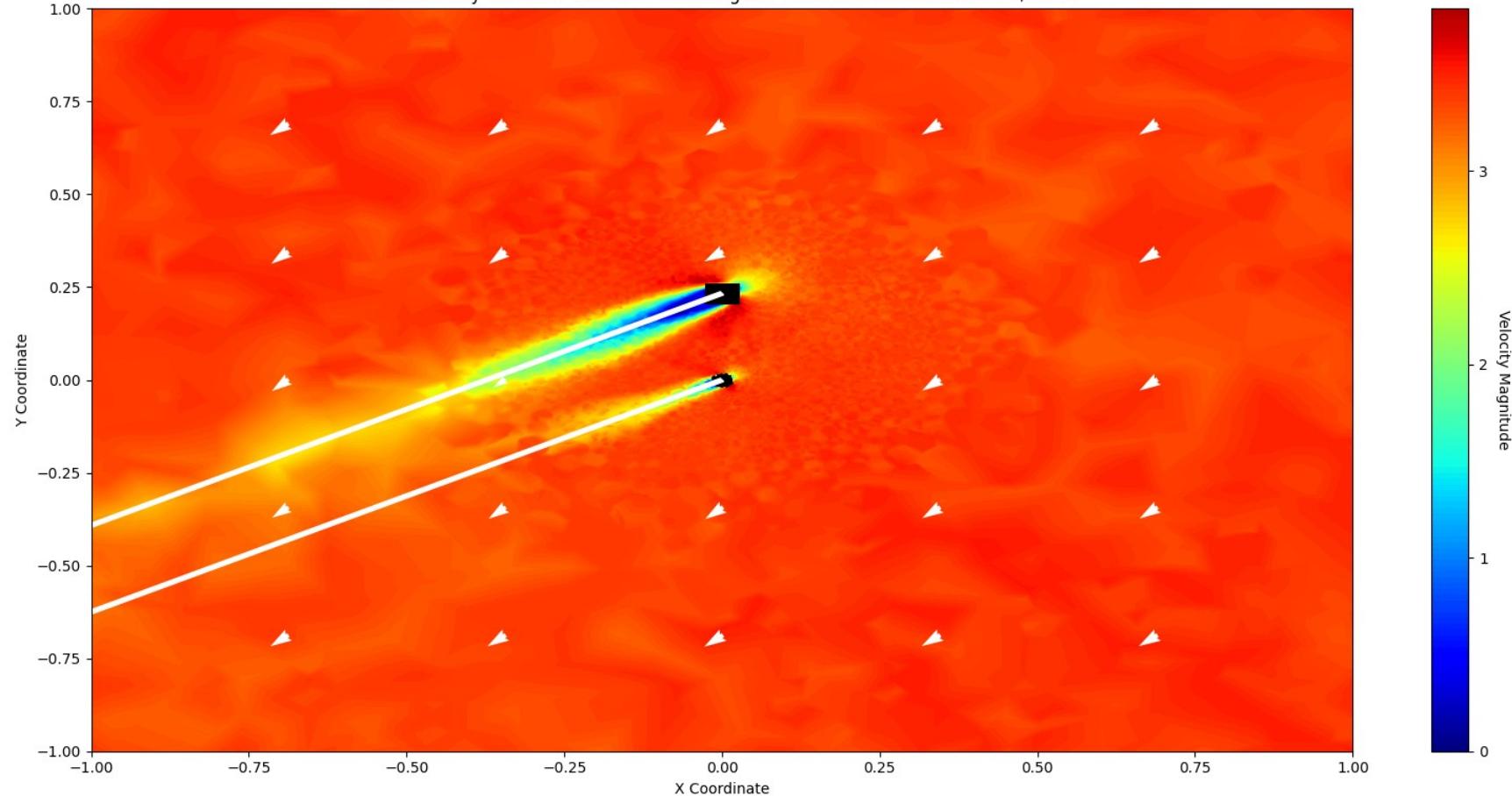
Total Velocity in the X-Y Plane for Wind Angle = 56 with a cut at Z = 0.17 +/- 0.02



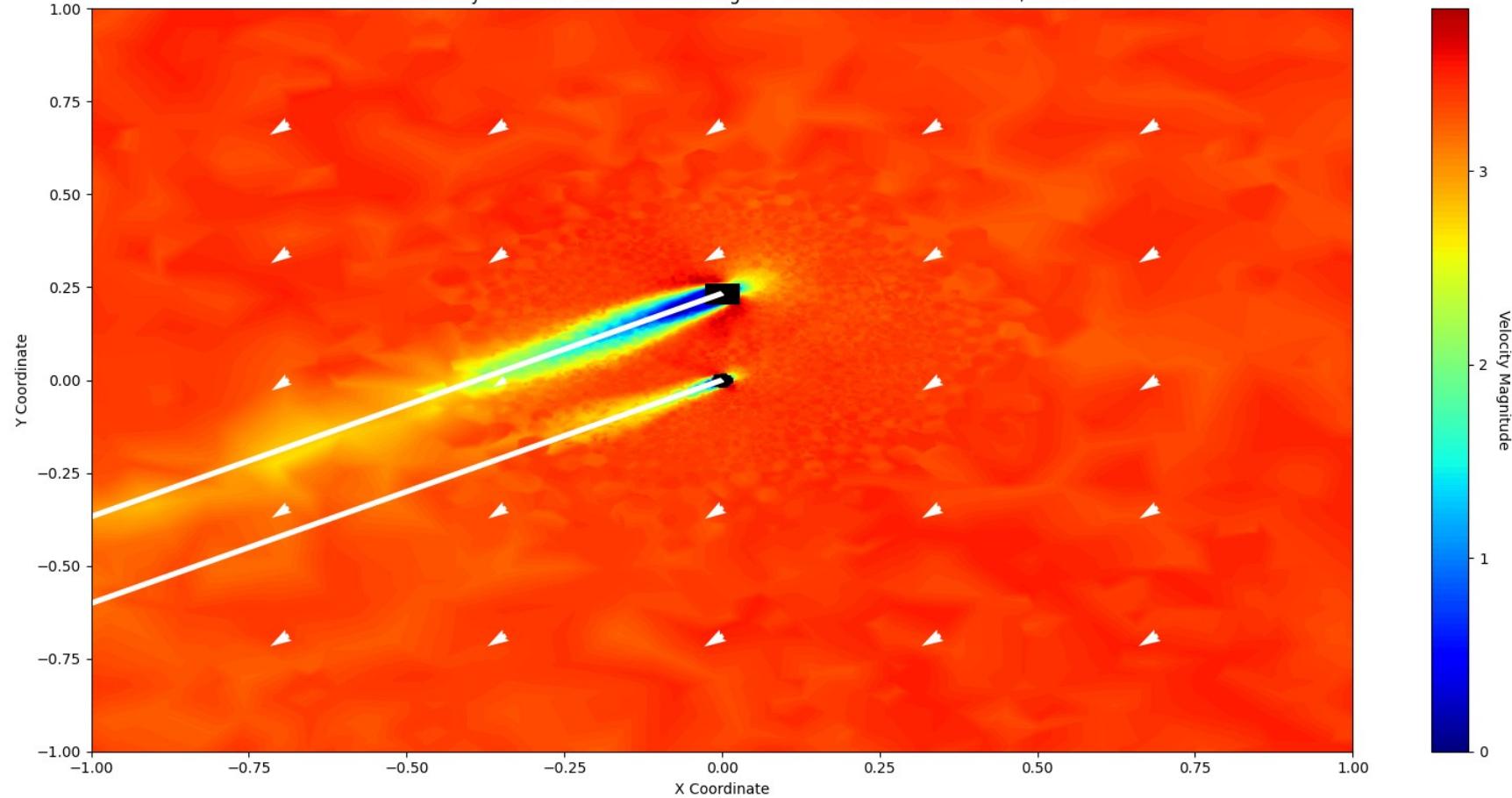
Total Velocity in the X-Y Plane for Wind Angle = 57 with a cut at Z = 0.17 +/- 0.02



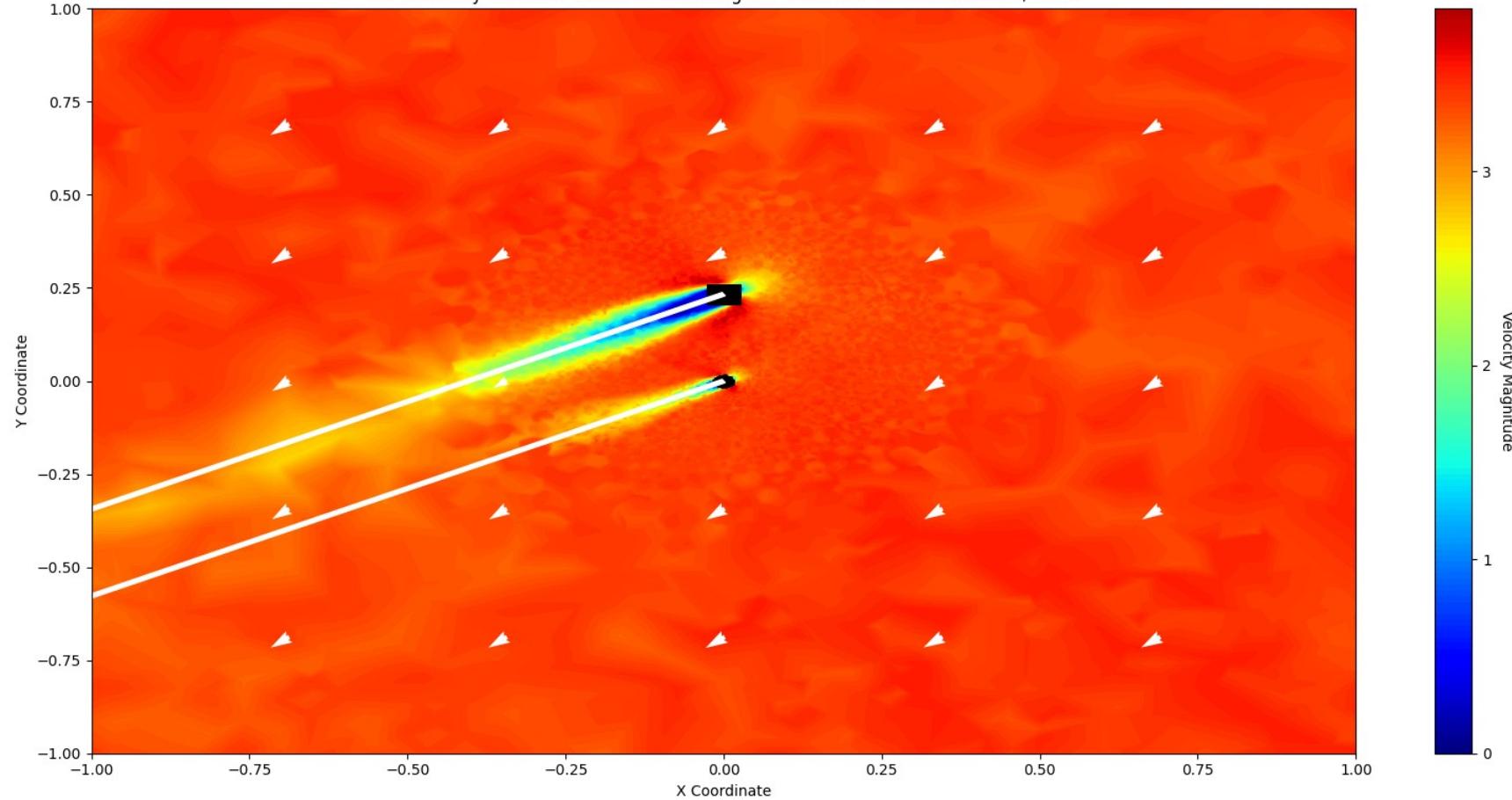
Total Velocity in the X-Y Plane for Wind Angle = 58 with a cut at Z = 0.17 +/- 0.02



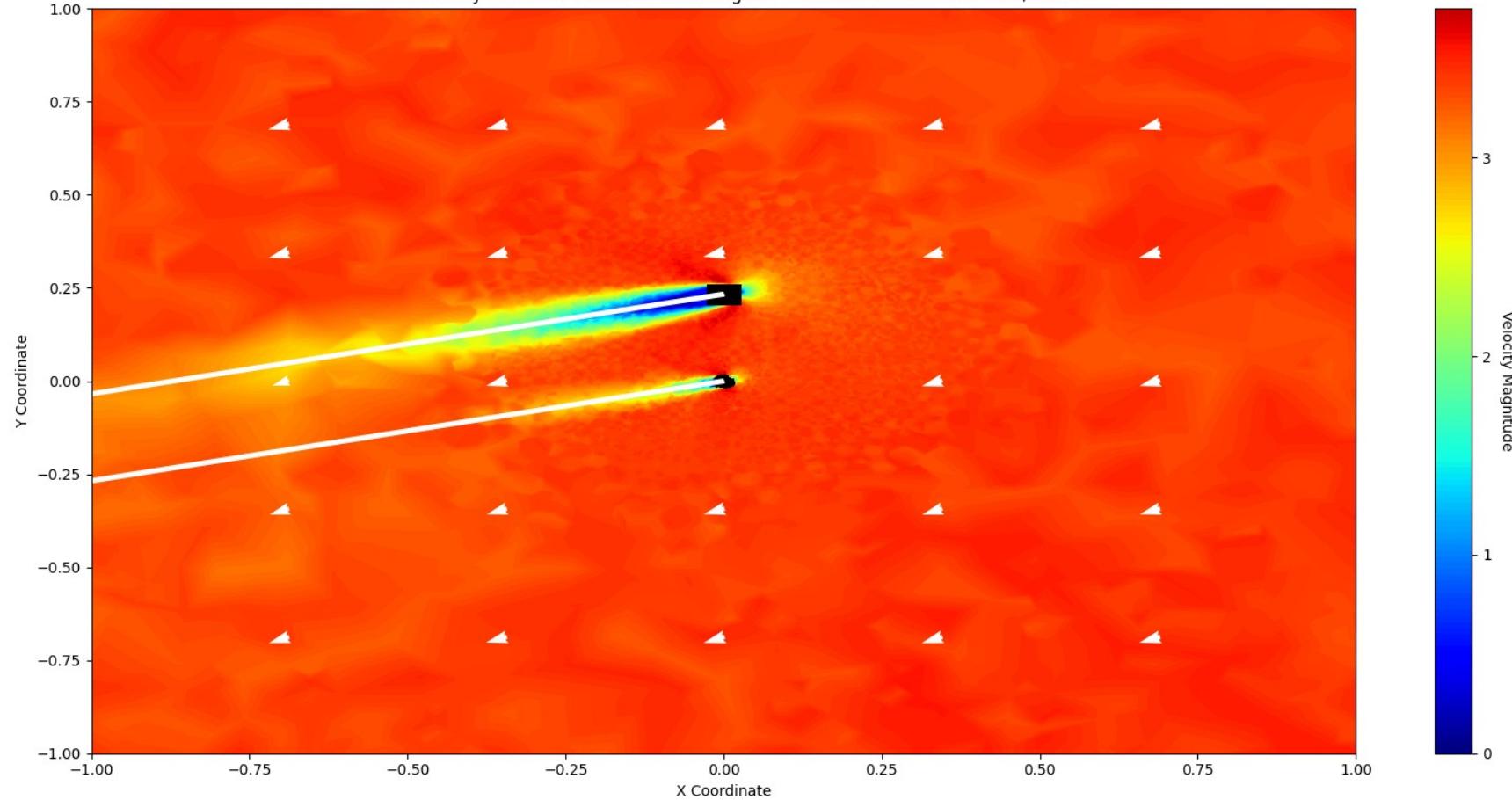
Total Velocity in the X-Y Plane for Wind Angle = 59 with a cut at Z = 0.17 +/- 0.02



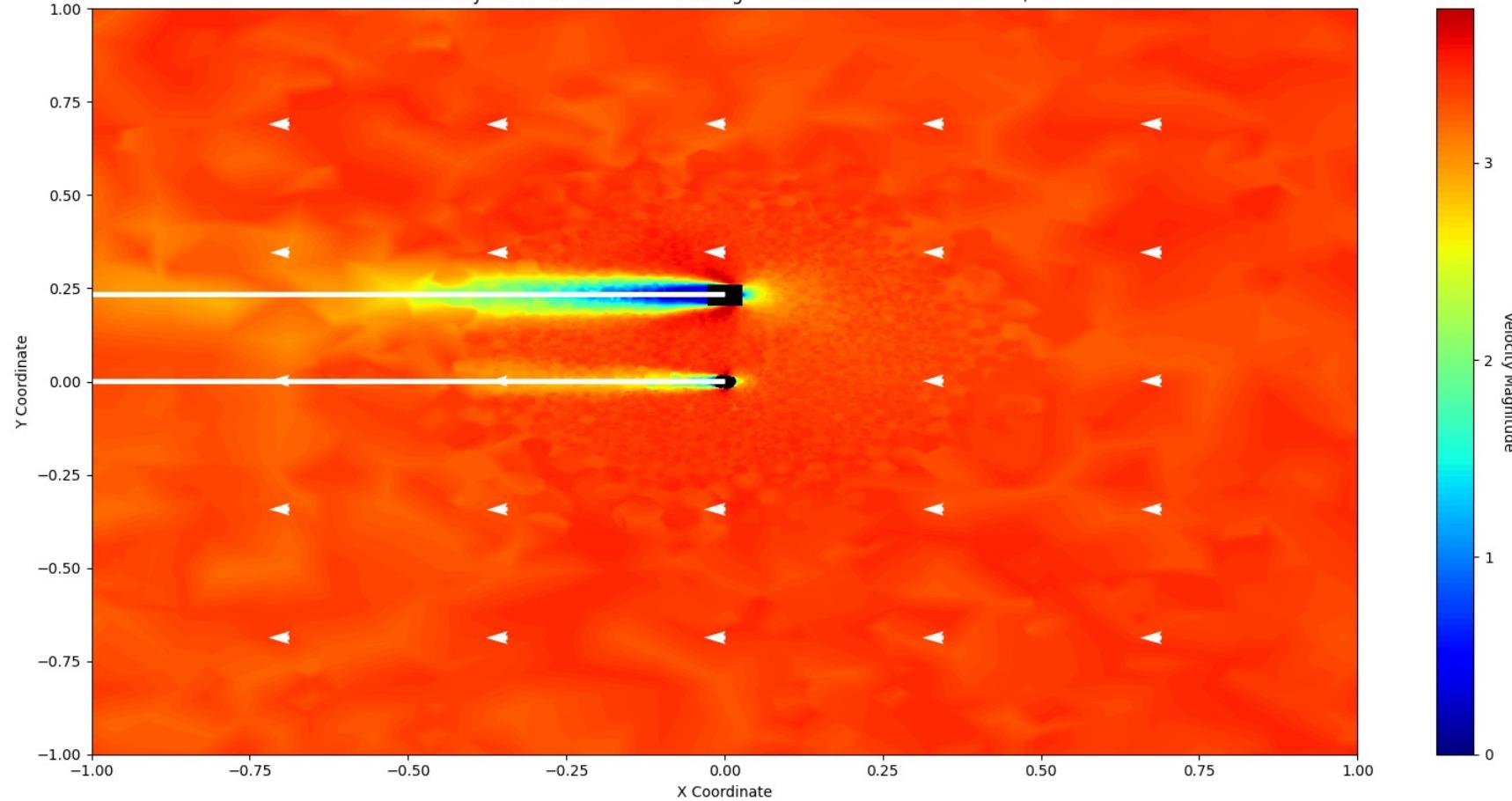
Total Velocity in the X-Y Plane for Wind Angle = 60 with a cut at Z = 0.17 +/- 0.02



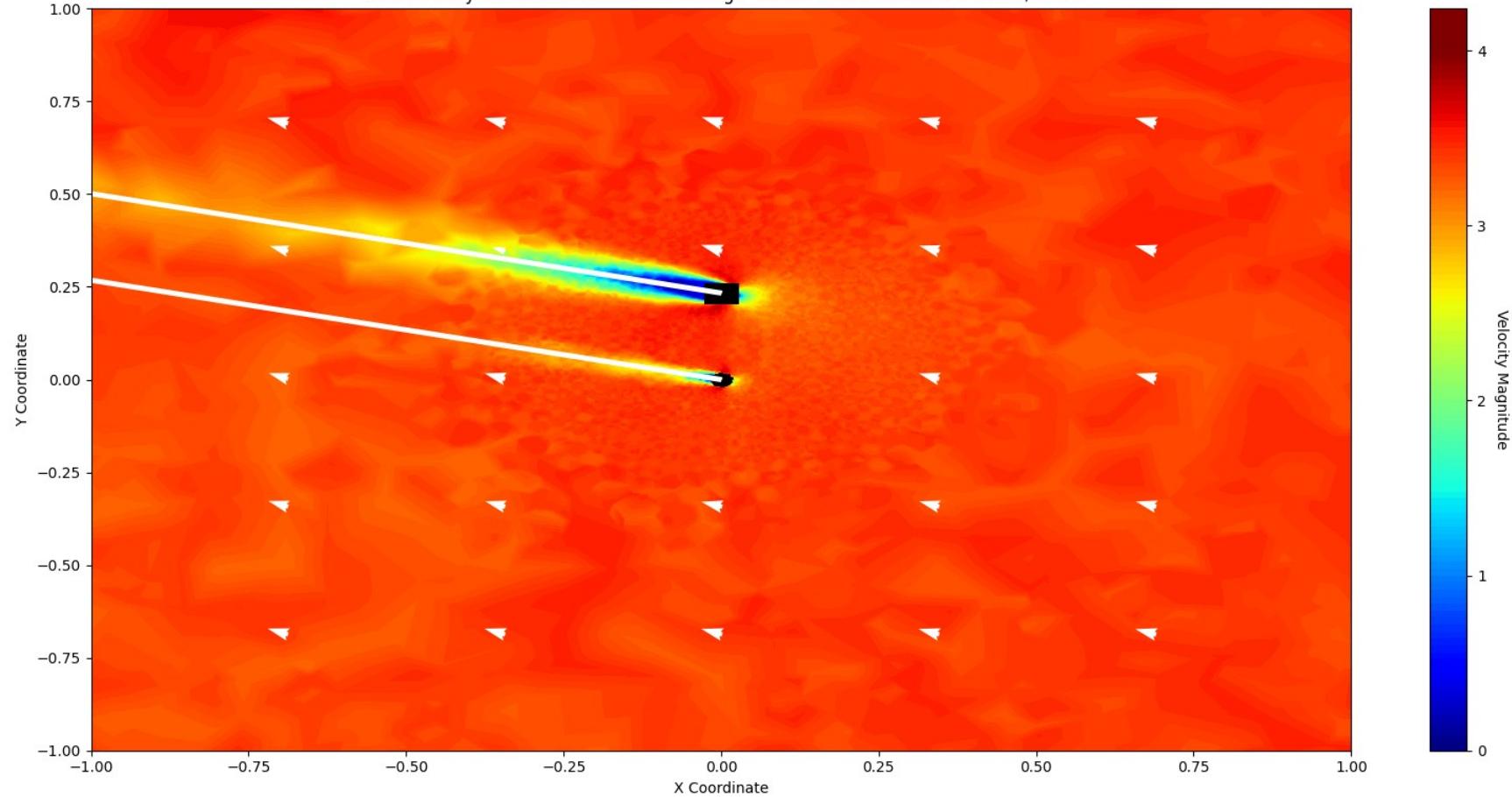
Total Velocity in the X-Y Plane for Wind Angle = 75 with a cut at Z = 0.17 +/- 0.02



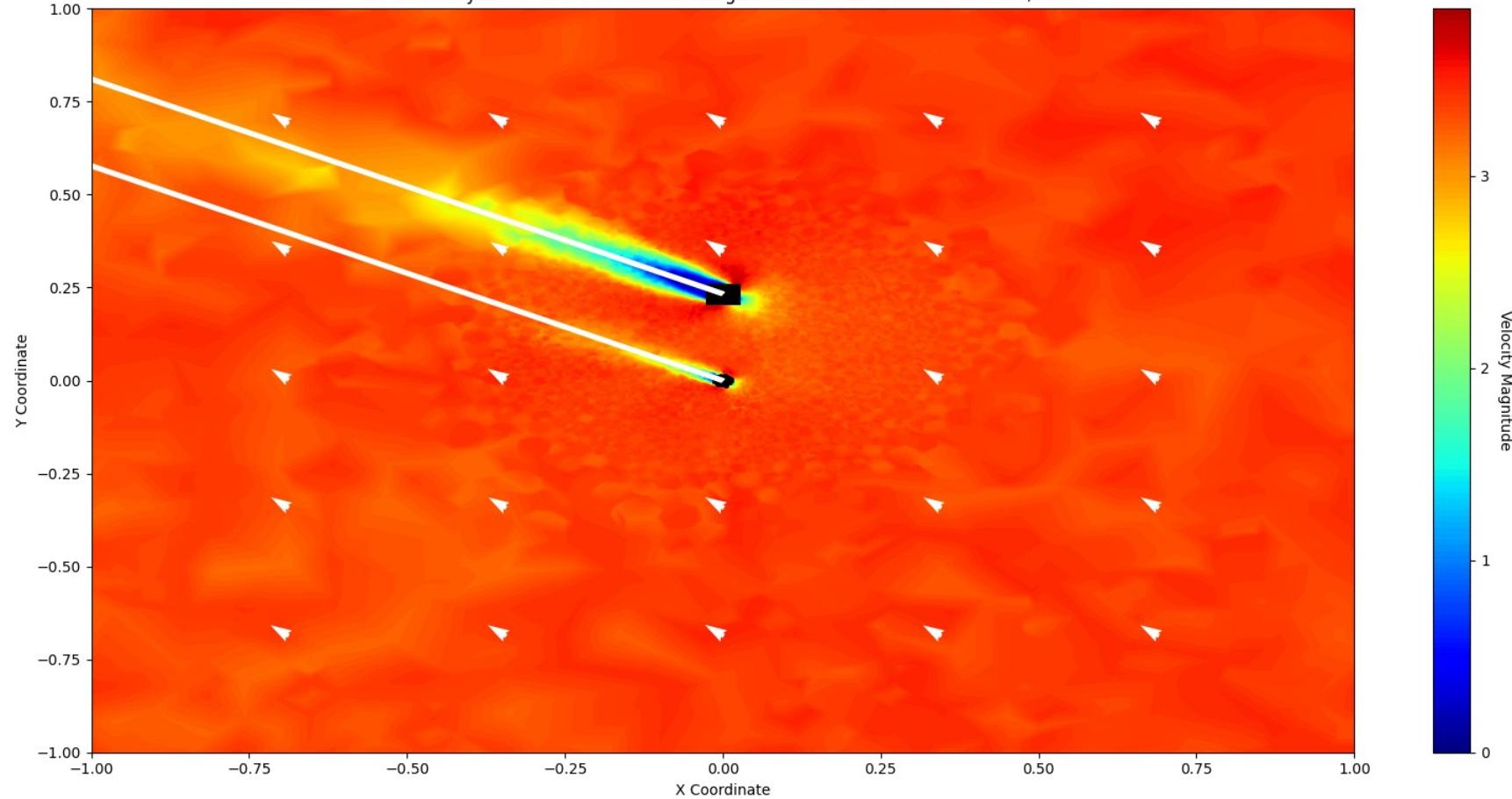
Total Velocity in the X-Y Plane for Wind Angle = 90 with a cut at Z = 0.17 +/- 0.02



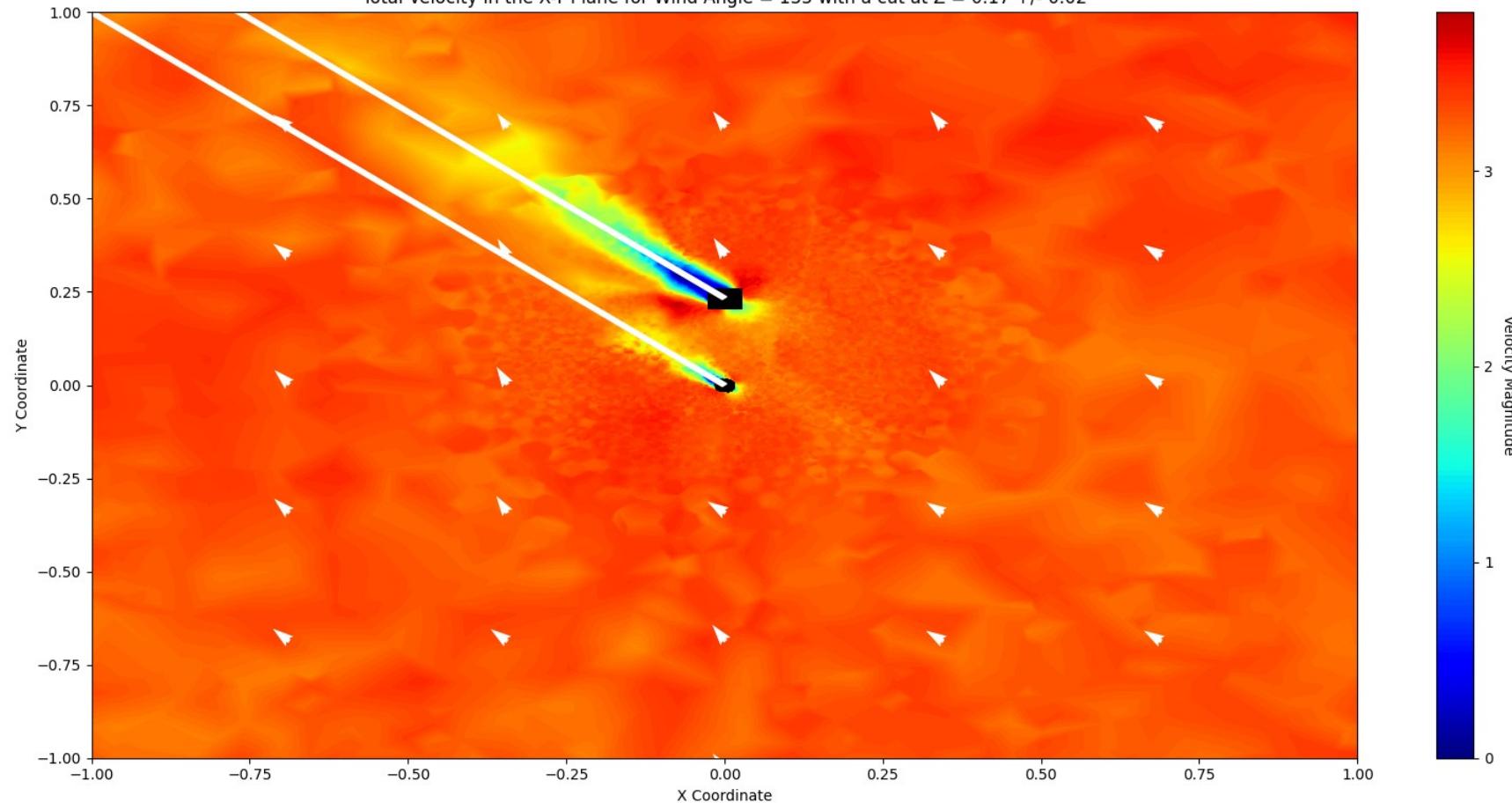
Total Velocity in the X-Y Plane for Wind Angle = 105 with a cut at Z = 0.17 +/- 0.02



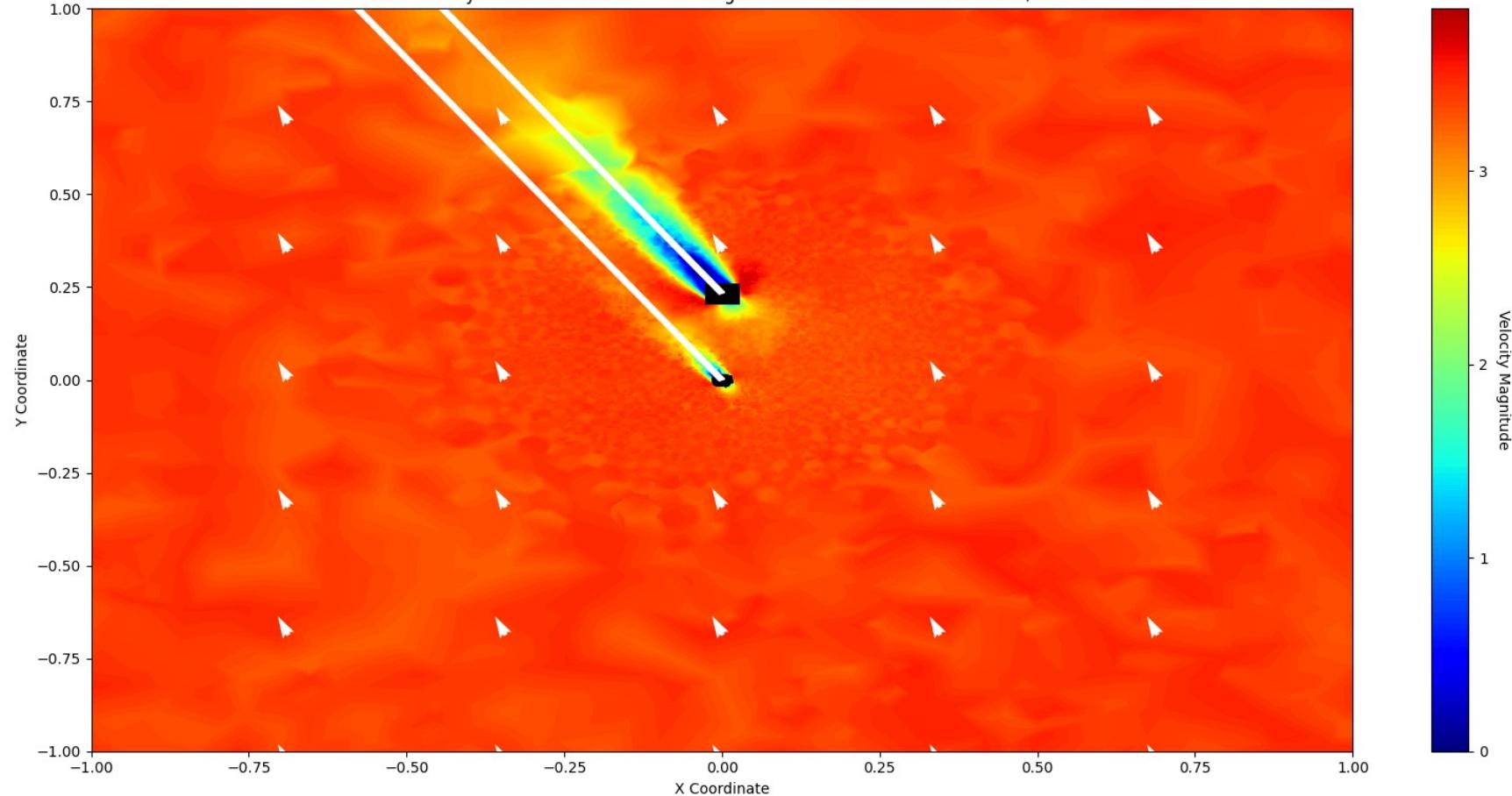
Total Velocity in the X-Y Plane for Wind Angle = 120 with a cut at Z = 0.17 +/- 0.02



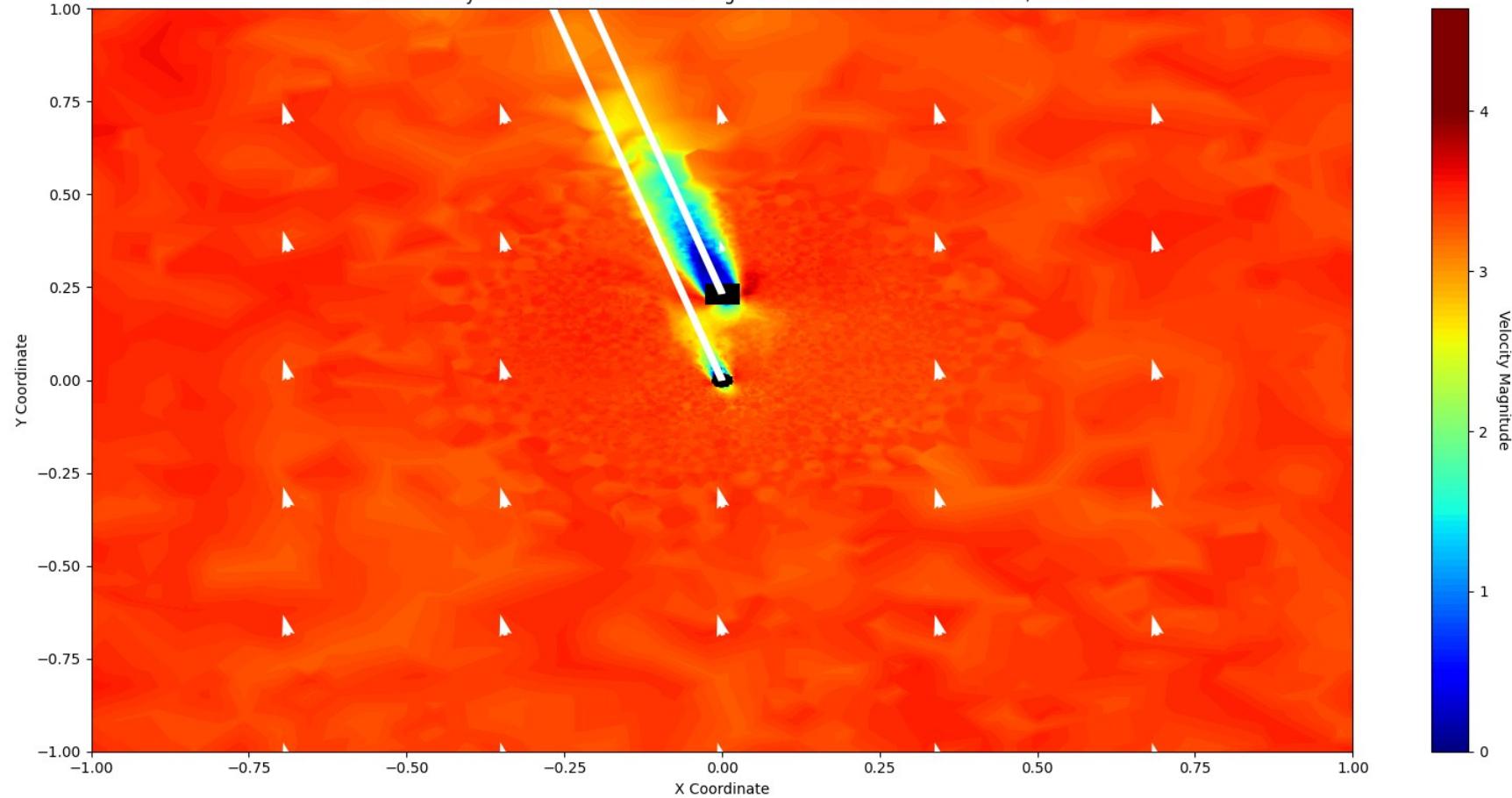
Total Velocity in the X-Y Plane for Wind Angle = 135 with a cut at Z = 0.17 +/- 0.02



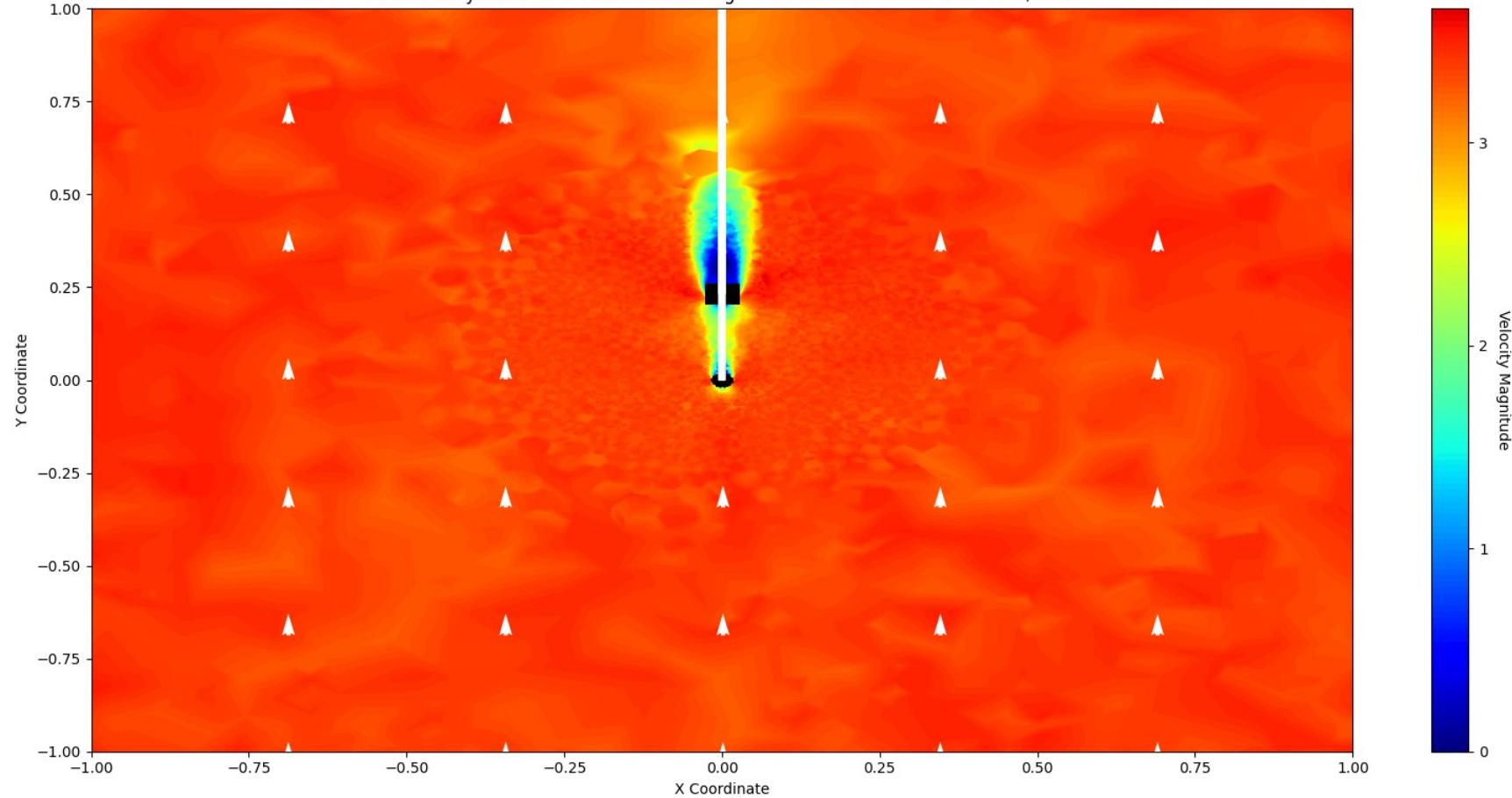
Total Velocity in the X-Y Plane for Wind Angle = 150 with a cut at Z = 0.17 +/- 0.02



Total Velocity in the X-Y Plane for Wind Angle = 165 with a cut at Z = 0.17 +/- 0.02



Total Velocity in the X-Y Plane for Wind Angle = 180 with a cut at Z = 0.17 +/- 0.02



Progress so far - Data + No Slip + Inlet Loss
Standard Normal Scalar
(Adam Optimizer)

Threshold = 1E-5 (2215 Epochs, not completed), GPU Workstation

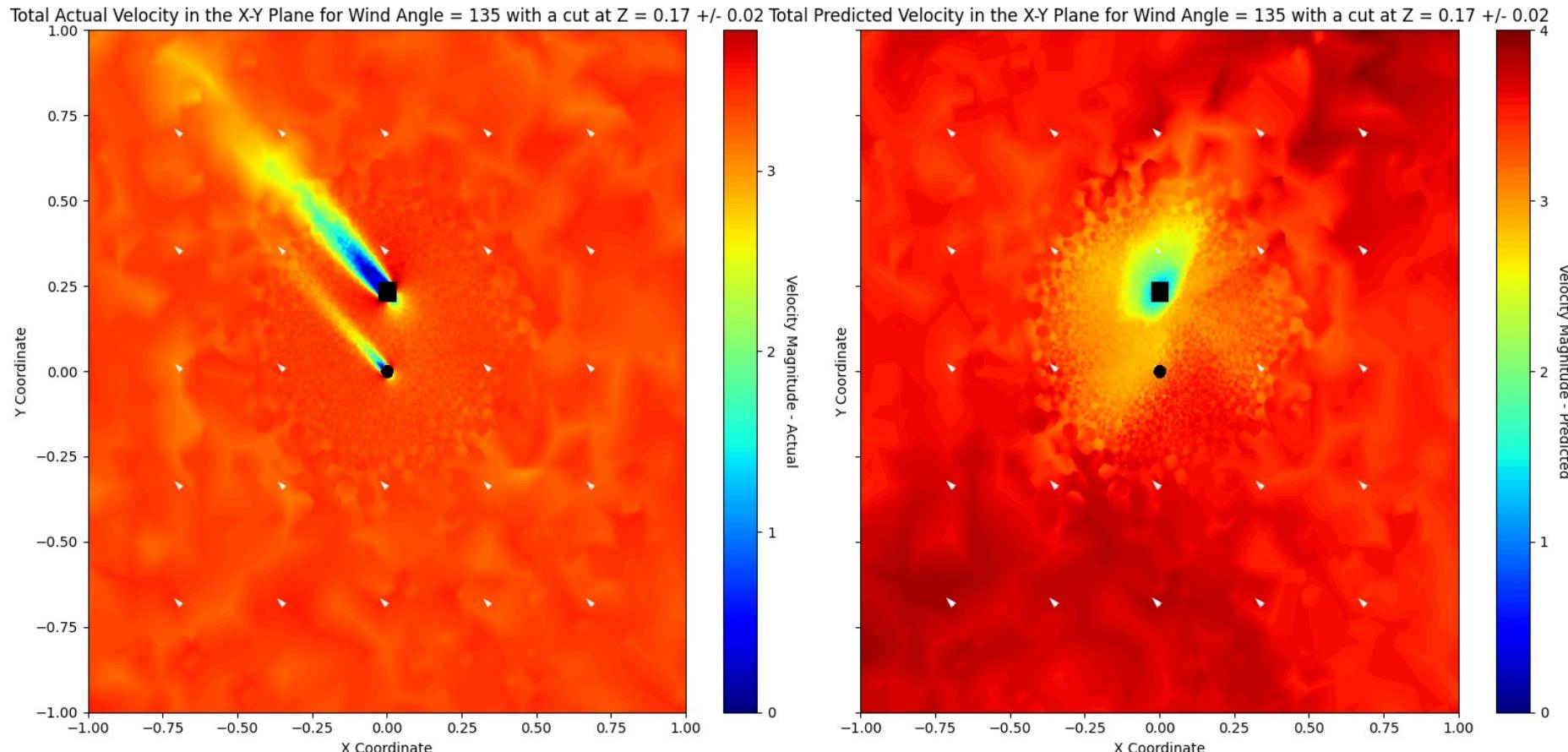
Scripts v4 – PREDICTING (135 DEG)

Progress so far - Data + No Slip + Inlet Loss (Adam Optimizer – Std Normal Scalar)
Threshold = 1E-5 (2215 Epochs, so far...), GPU Workstation
Predicting Results – Metrics (Angle = 135)

Variable	MSE	RMSE	MAE	R2
Velocity:0	0.180166510802504	0.424460258213304	0.241915616710653	0.823232241674705
Velocity:1	0.189689449807947	0.43553352317353	0.266575881972611	0.815663281490145
Velocity:2	0.0126651486614695	0.112539542657101	0.0523497251641134	0.612853046764769

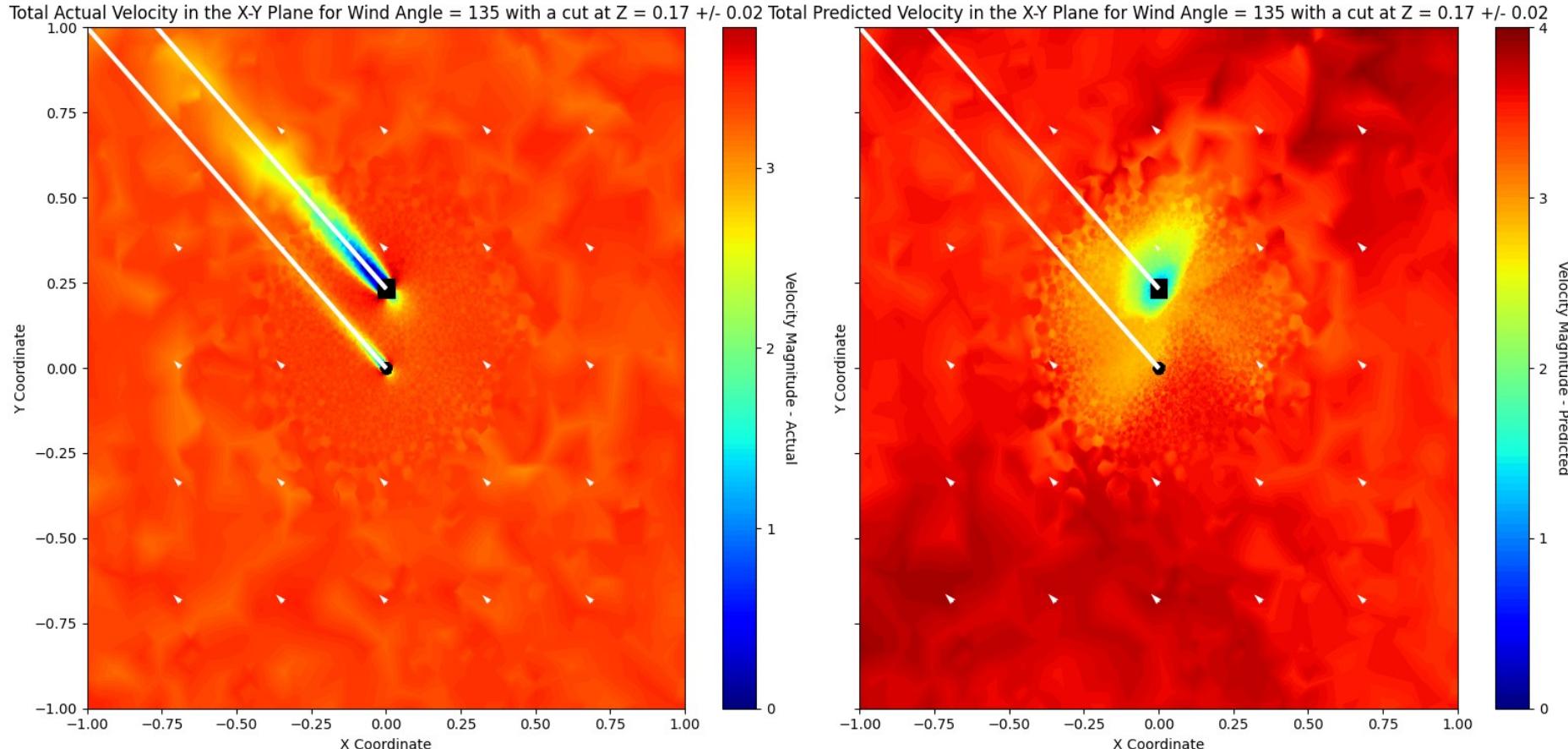
Progress so far - Data + No Slip + Inlet Loss (Adam Optimizer – Std Normal Scalar), Threshold = 1E-5 (2215 Epochs, so far...), GPU Workstation
Predicting Results - X-Y Total Velocity Plot (Angle = 135)

Comparison of Actual vs. Predicted values with Wind Angle = 135 in the X-Y Plane with a cut at Z = 0.17 +/- 0.02



Progress so far - Data + No Slip + Inlet Loss (Adam Optimizer – Std Normal Scalar), Threshold = 1E-5 (2215 Epochs, so far...), GPU Workstation
Predicting Results - X-Y Total Velocity Plot (Angle = 135)

Comparison of Actual vs. Predicted values with Wind Angle = 135 in the X-Y Plane with a cut at Z = 0.17 +/- 0.02

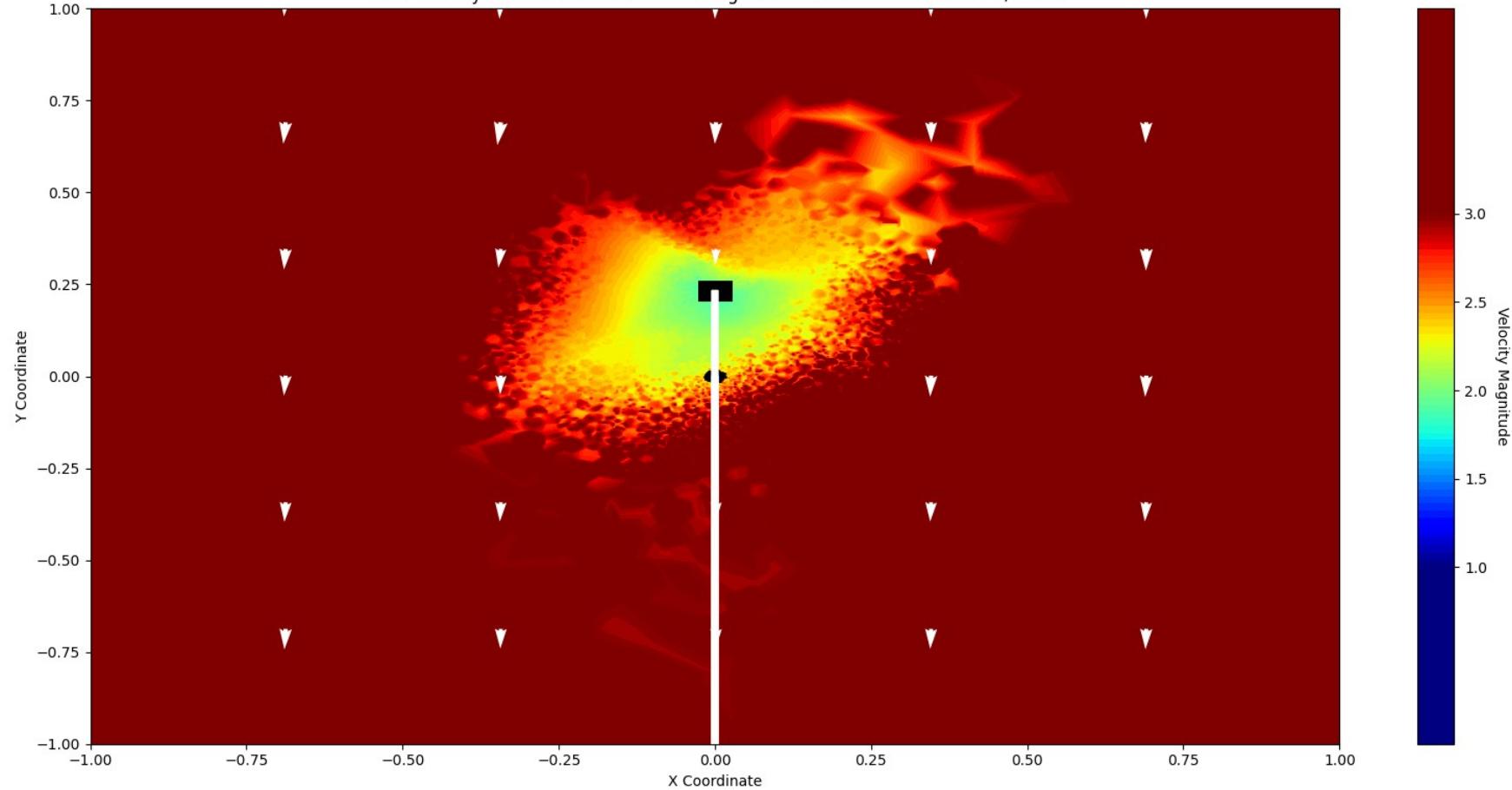


Progress so far - Data + No Slip + Inlet Loss
Standard Normal Scalar
(Adam Optimizer)

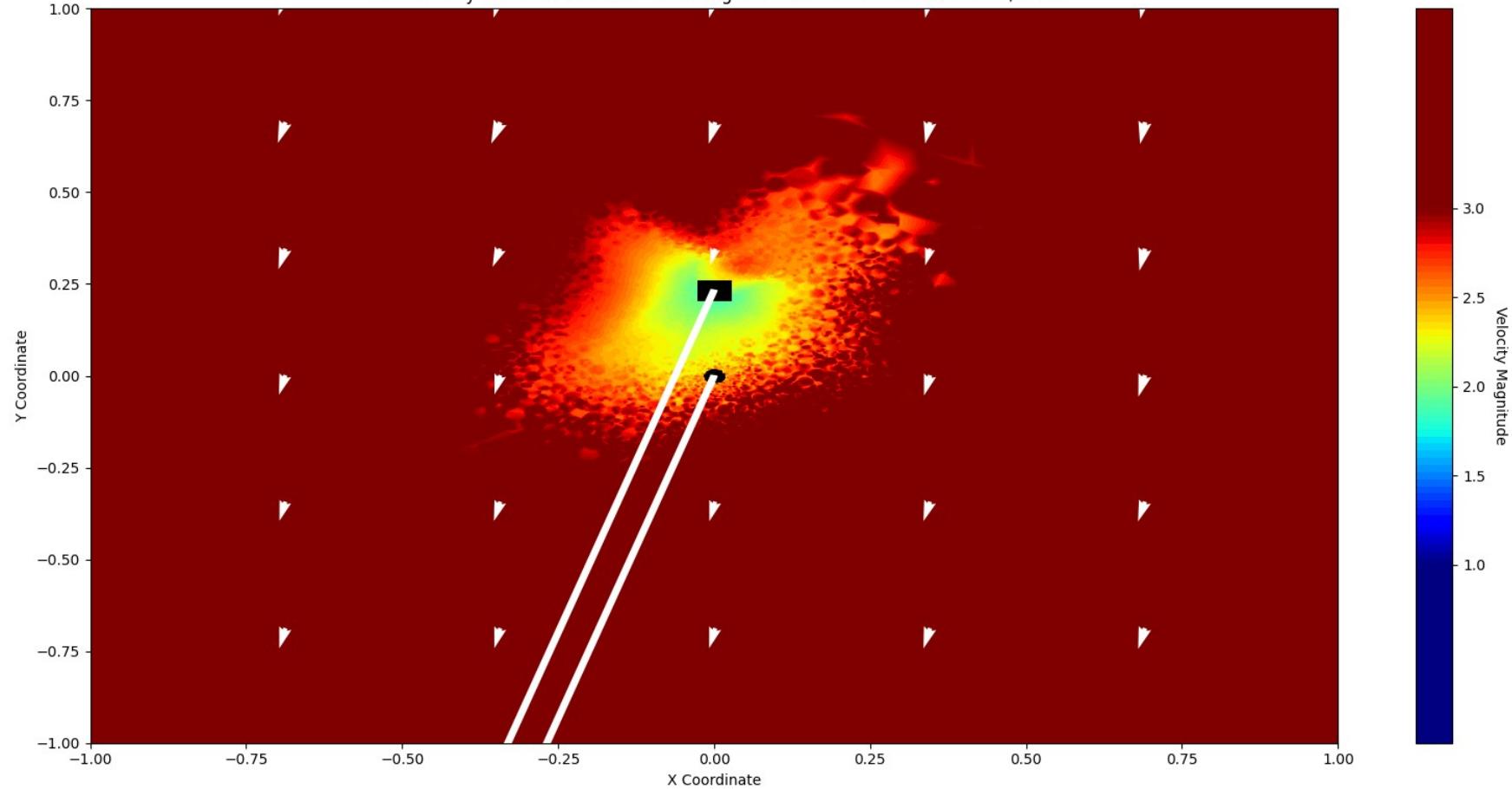
Threshold = 1E-5 (2215 Epochs, not completed), GPU Workstation

Scripts v4 – Plotting Any Angle

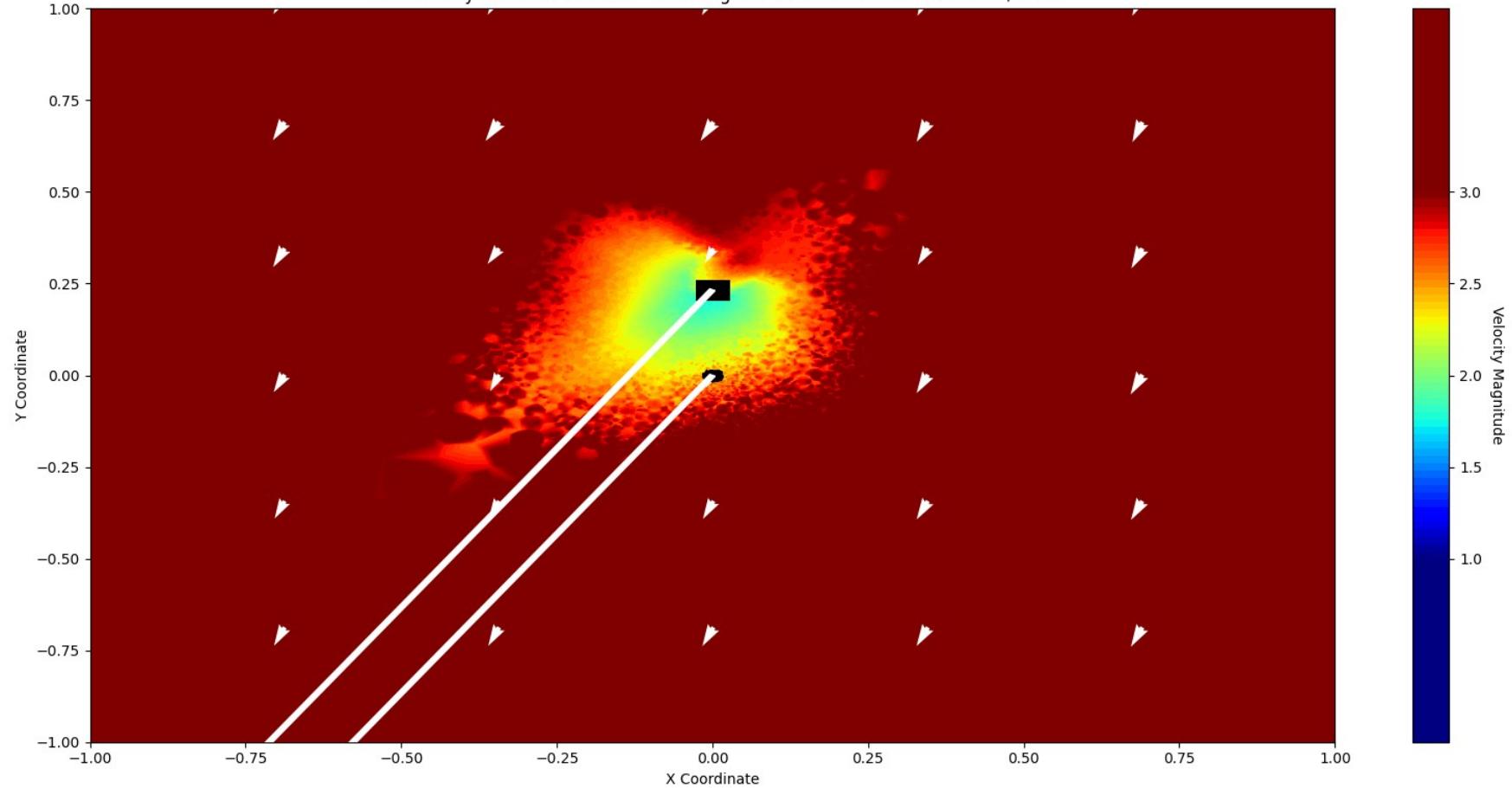
Total Velocity in the X-Y Plane for Wind Angle = 0 with a cut at Z = 0.17 +/- 0.02



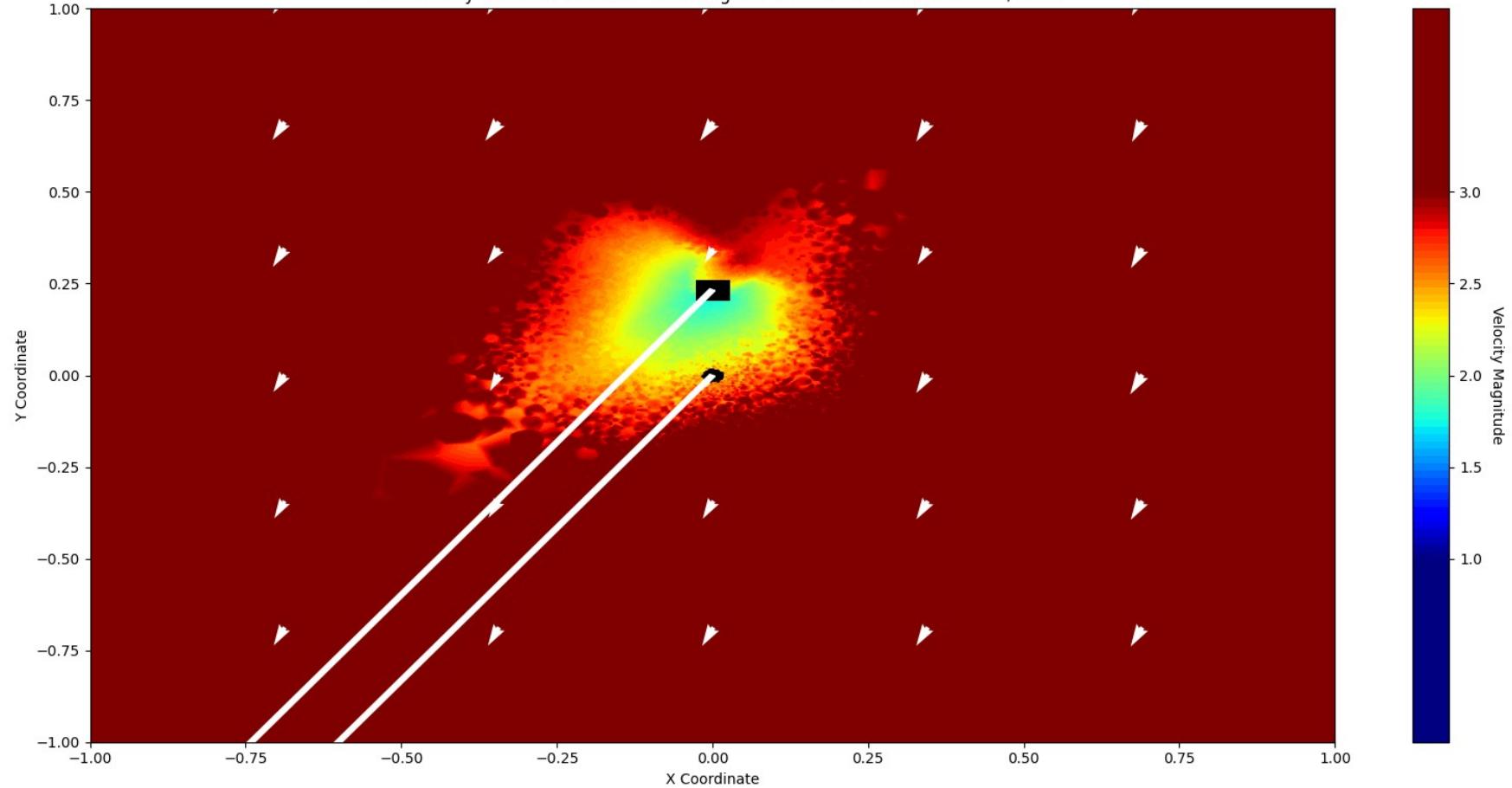
Total Velocity in the X-Y Plane for Wind Angle = 15 with a cut at Z = 0.17 +/- 0.02



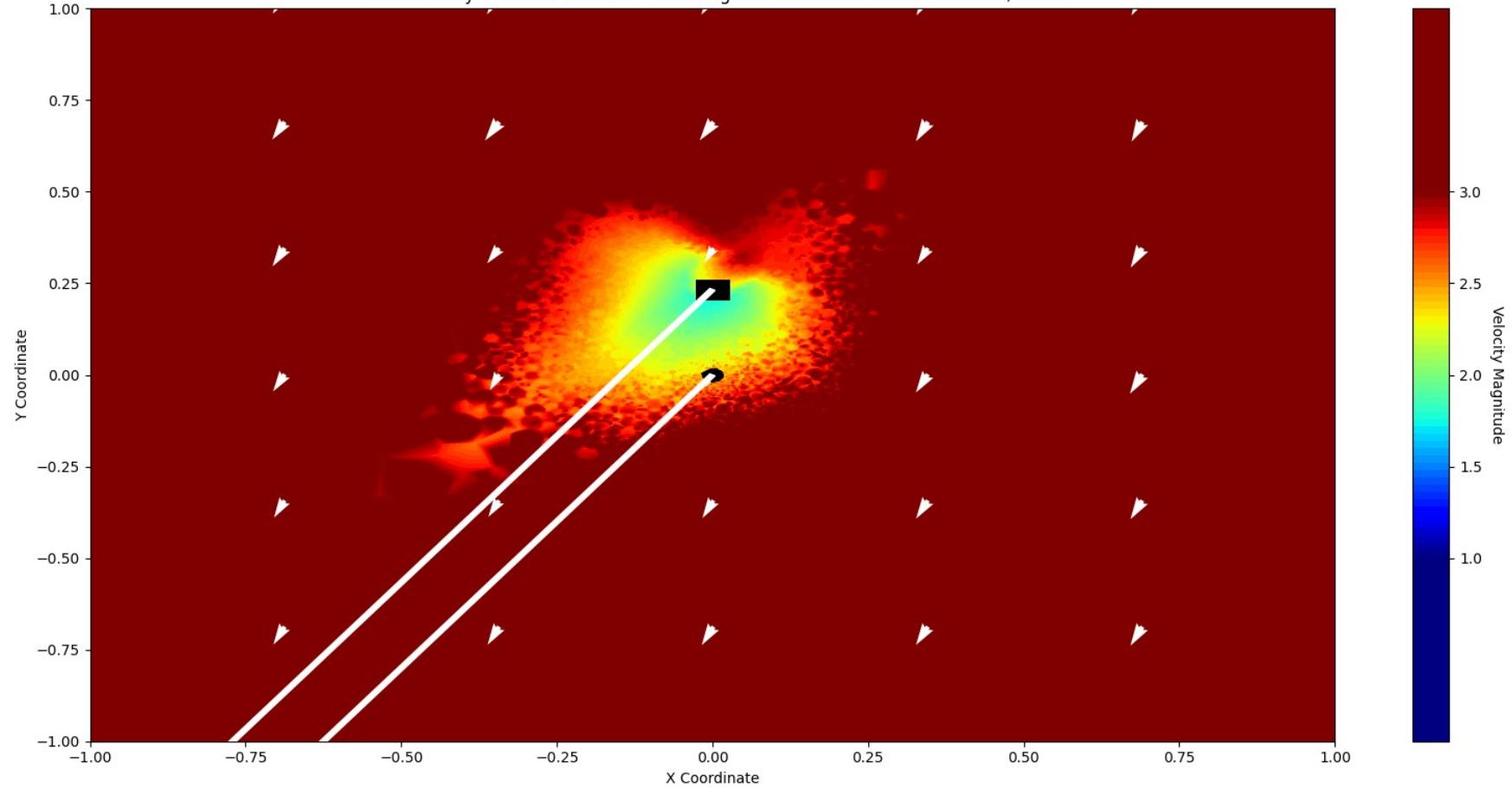
Total Velocity in the X-Y Plane for Wind Angle = 30 with a cut at Z = 0.17 +/- 0.02



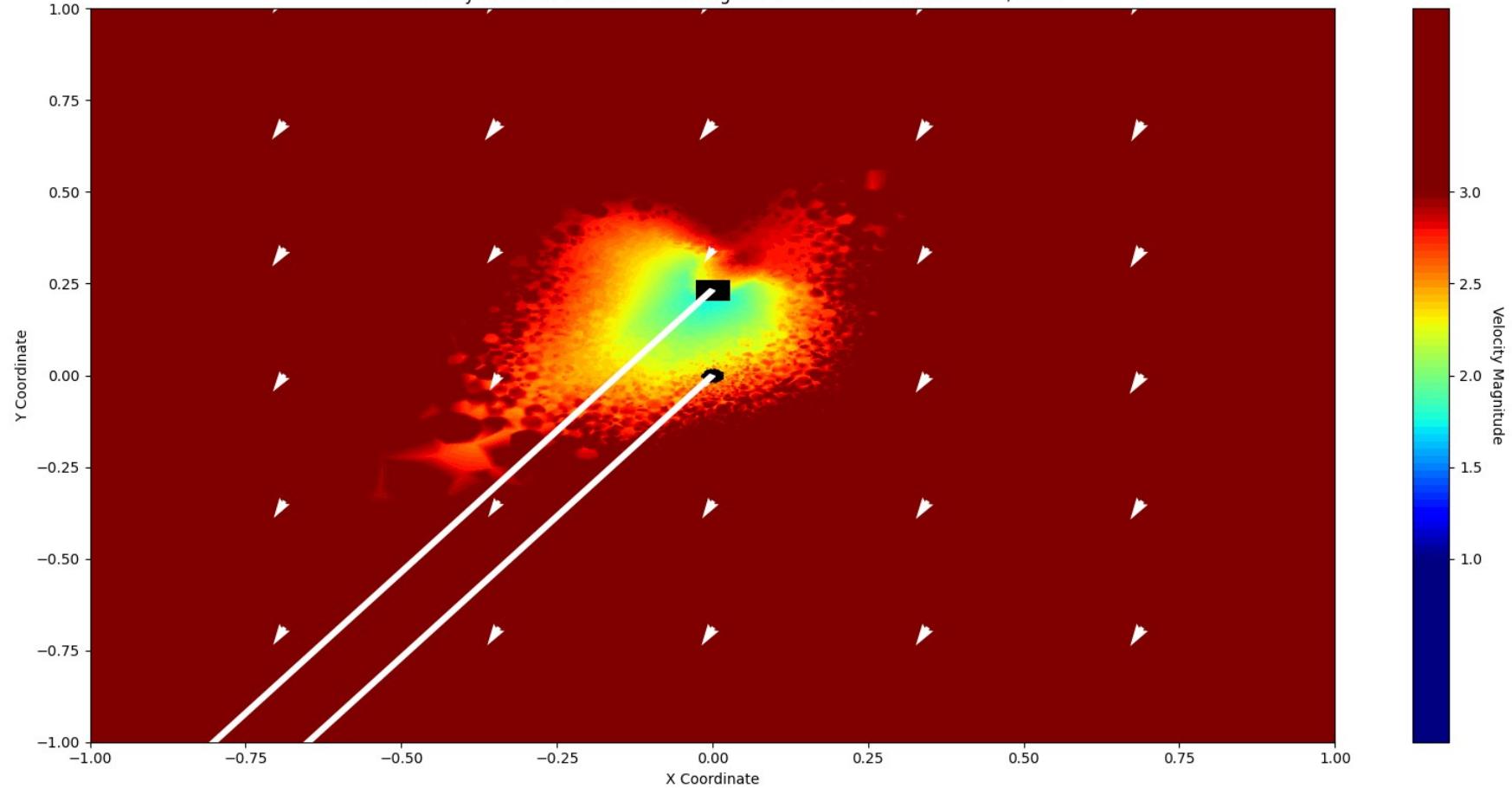
Total Velocity in the X-Y Plane for Wind Angle = 31 with a cut at Z = 0.17 +/- 0.02



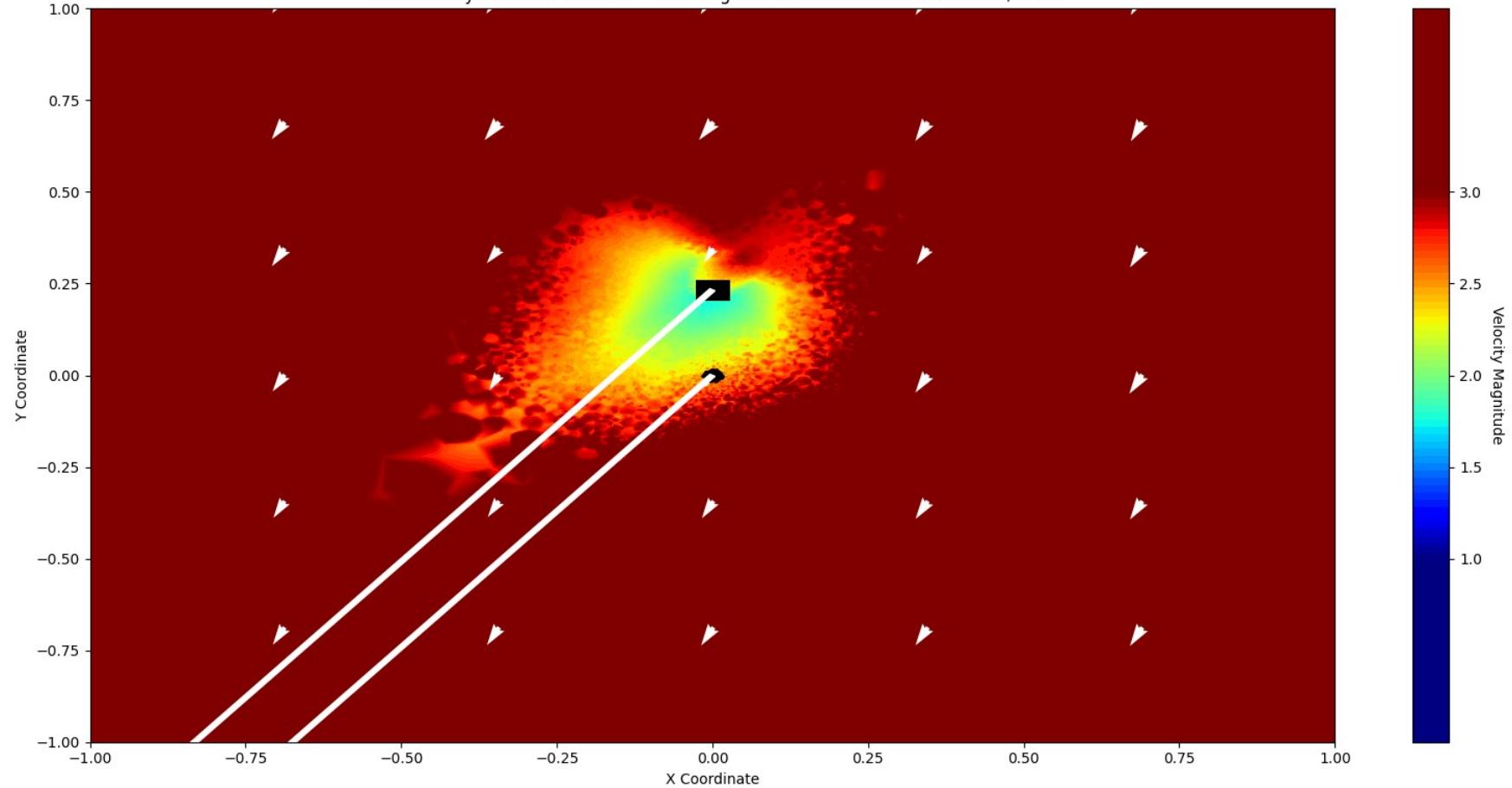
Total Velocity in the X-Y Plane for Wind Angle = 32 with a cut at Z = 0.17 +/- 0.02



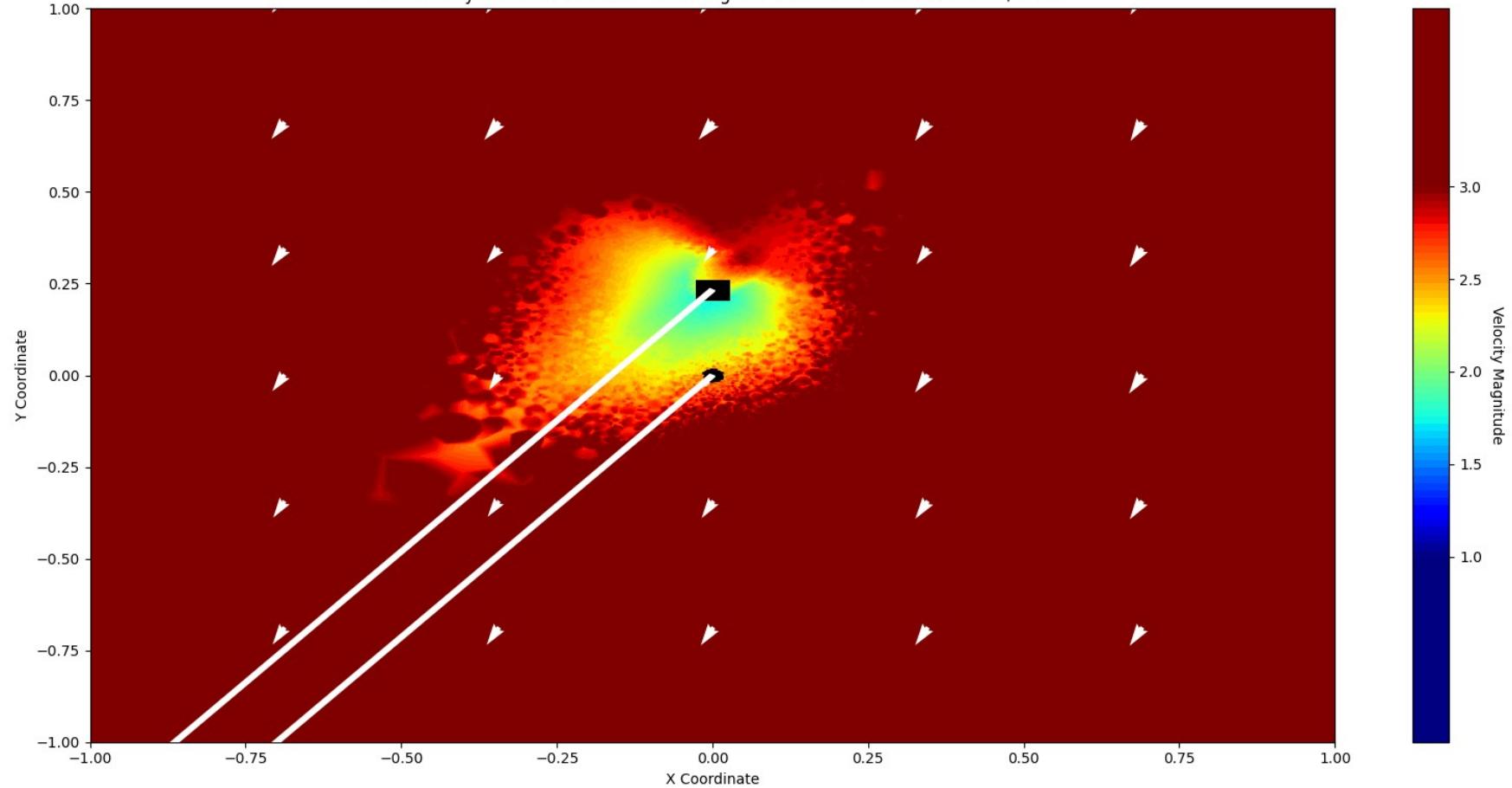
Total Velocity in the X-Y Plane for Wind Angle = 33 with a cut at Z = 0.17 +/- 0.02



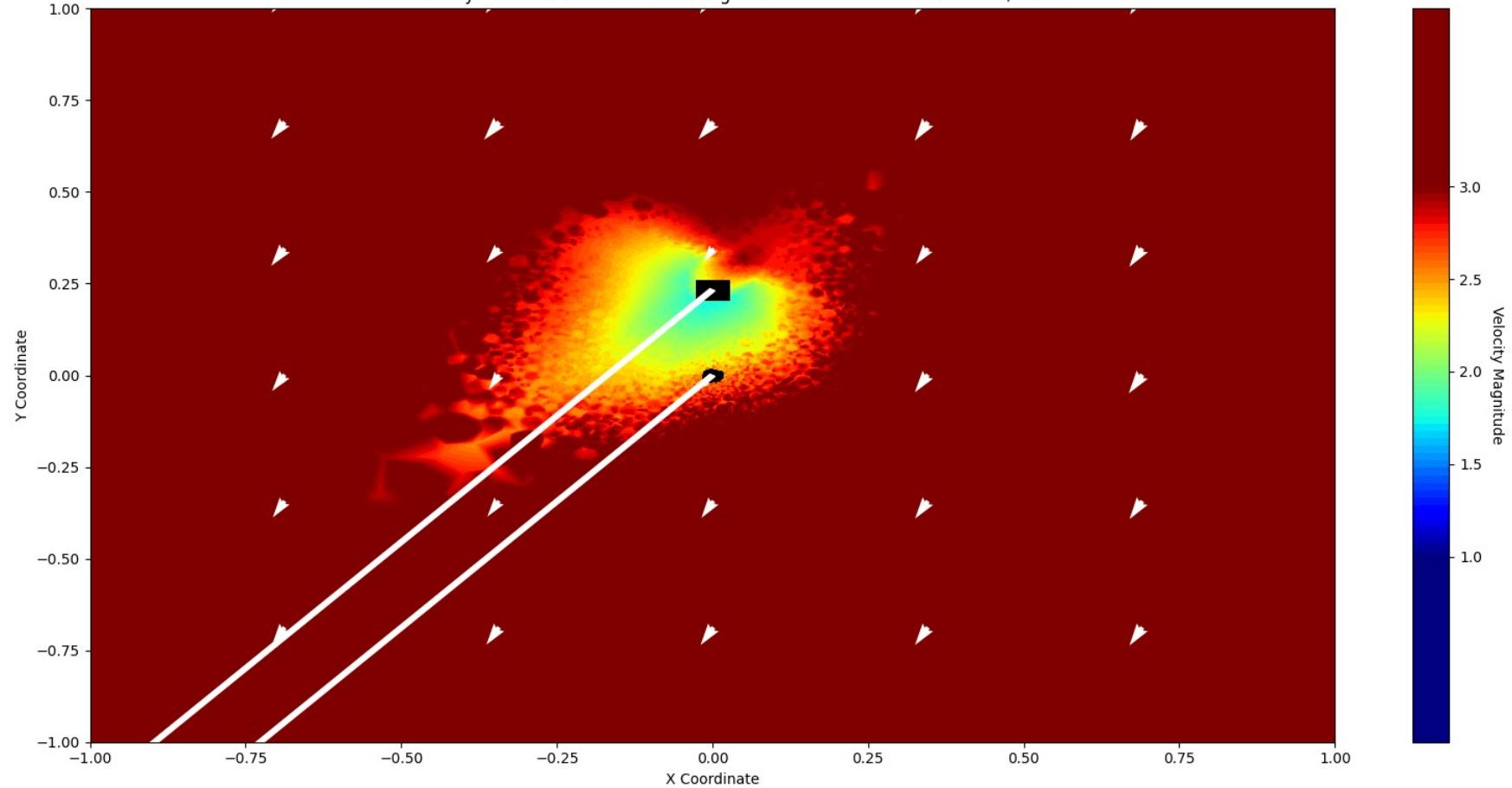
Total Velocity in the X-Y Plane for Wind Angle = 34 with a cut at Z = 0.17 +/- 0.02



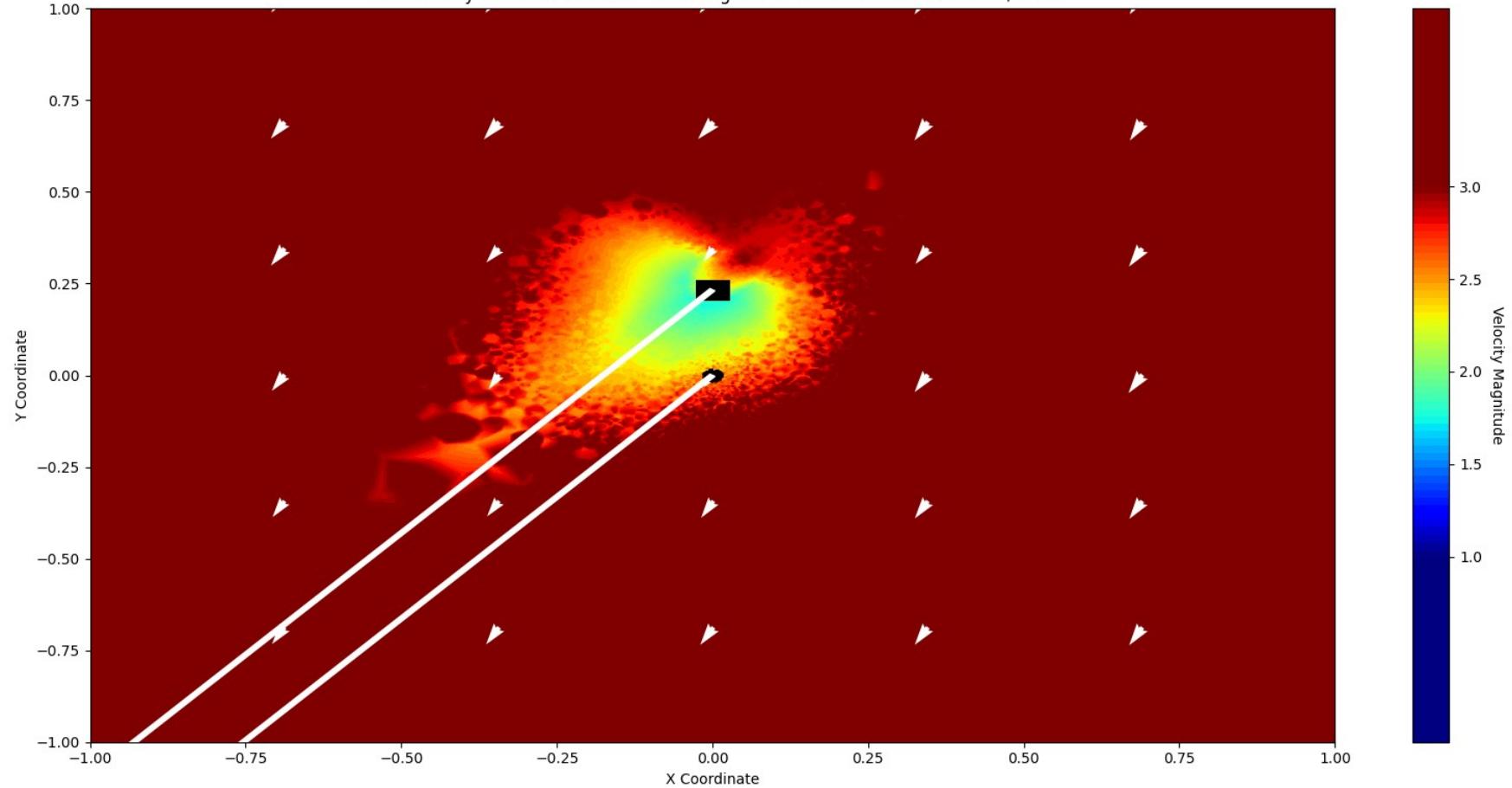
Total Velocity in the X-Y Plane for Wind Angle = 35 with a cut at Z = 0.17 +/- 0.02



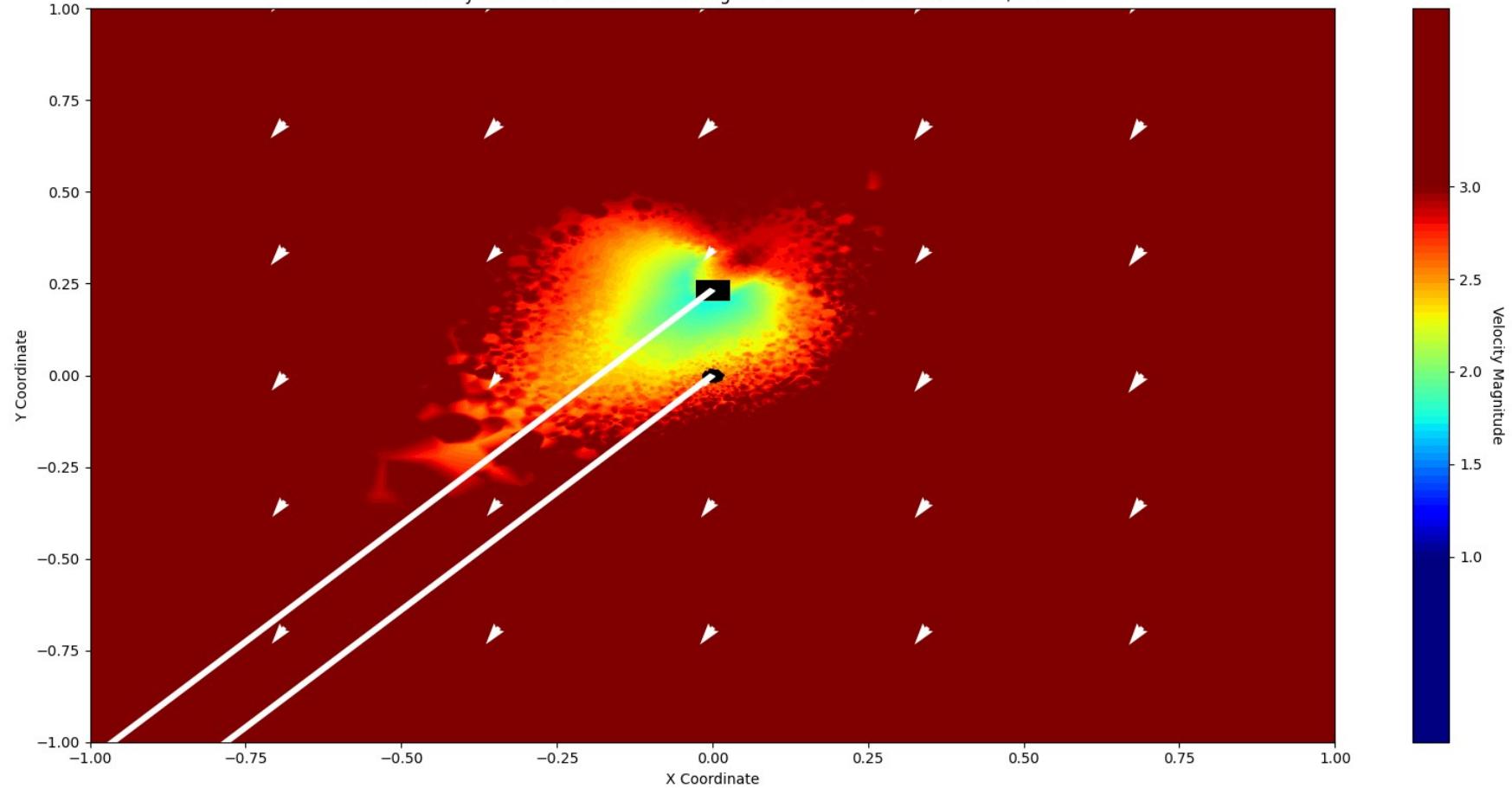
Total Velocity in the X-Y Plane for Wind Angle = 36 with a cut at Z = 0.17 +/- 0.02



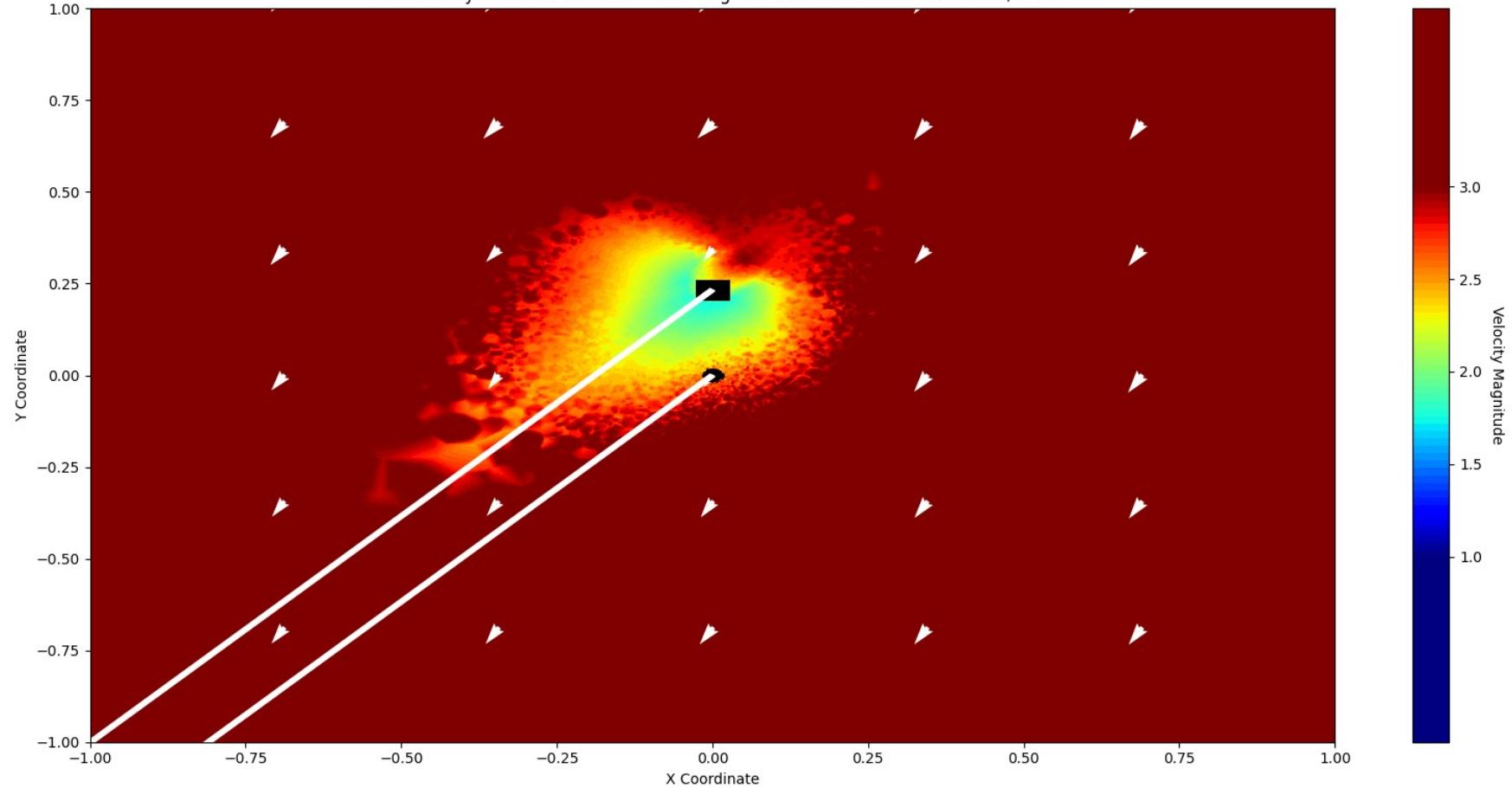
Total Velocity in the X-Y Plane for Wind Angle = 37 with a cut at Z = 0.17 +/- 0.02



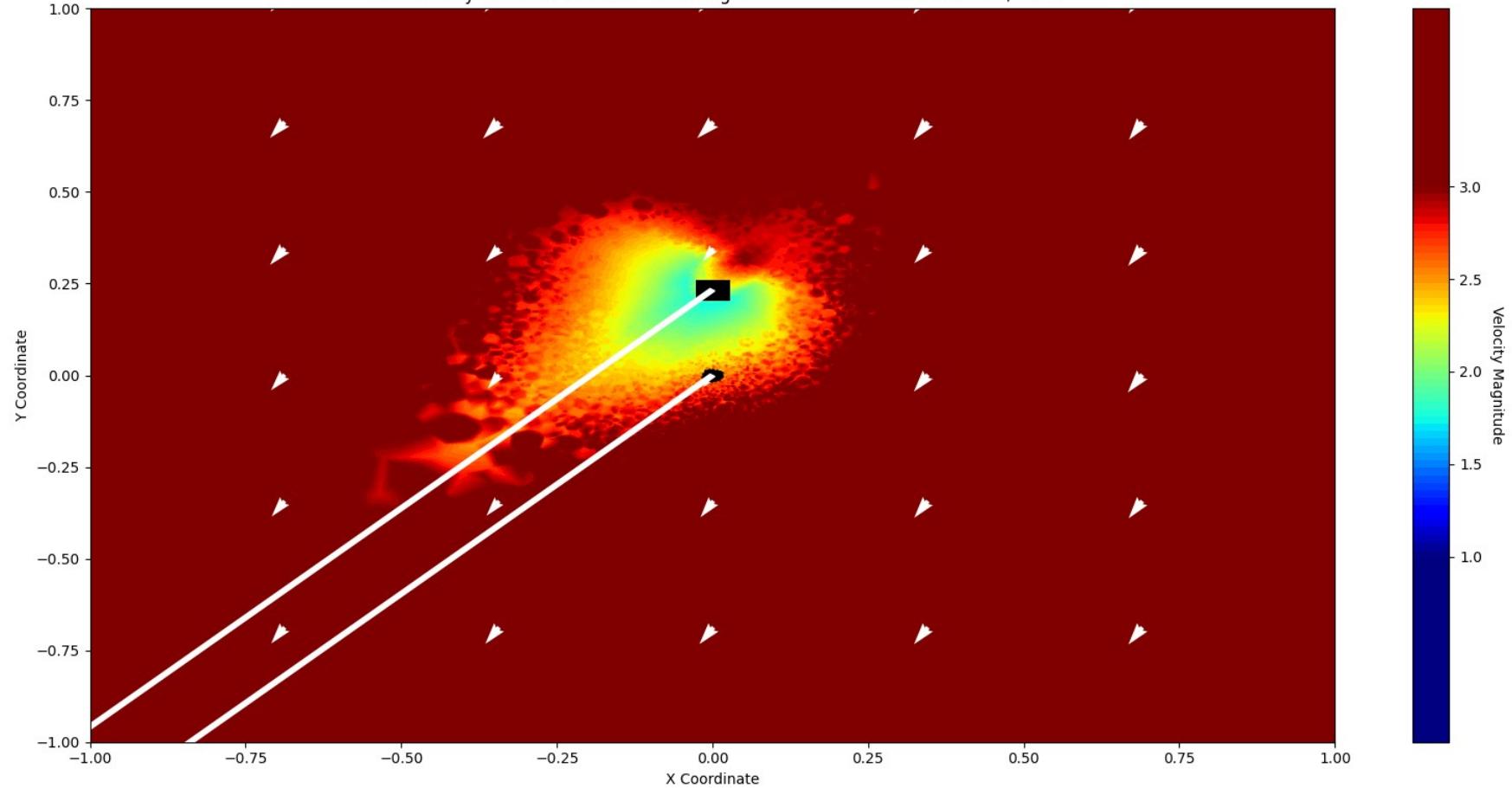
Total Velocity in the X-Y Plane for Wind Angle = 38 with a cut at Z = 0.17 +/- 0.02



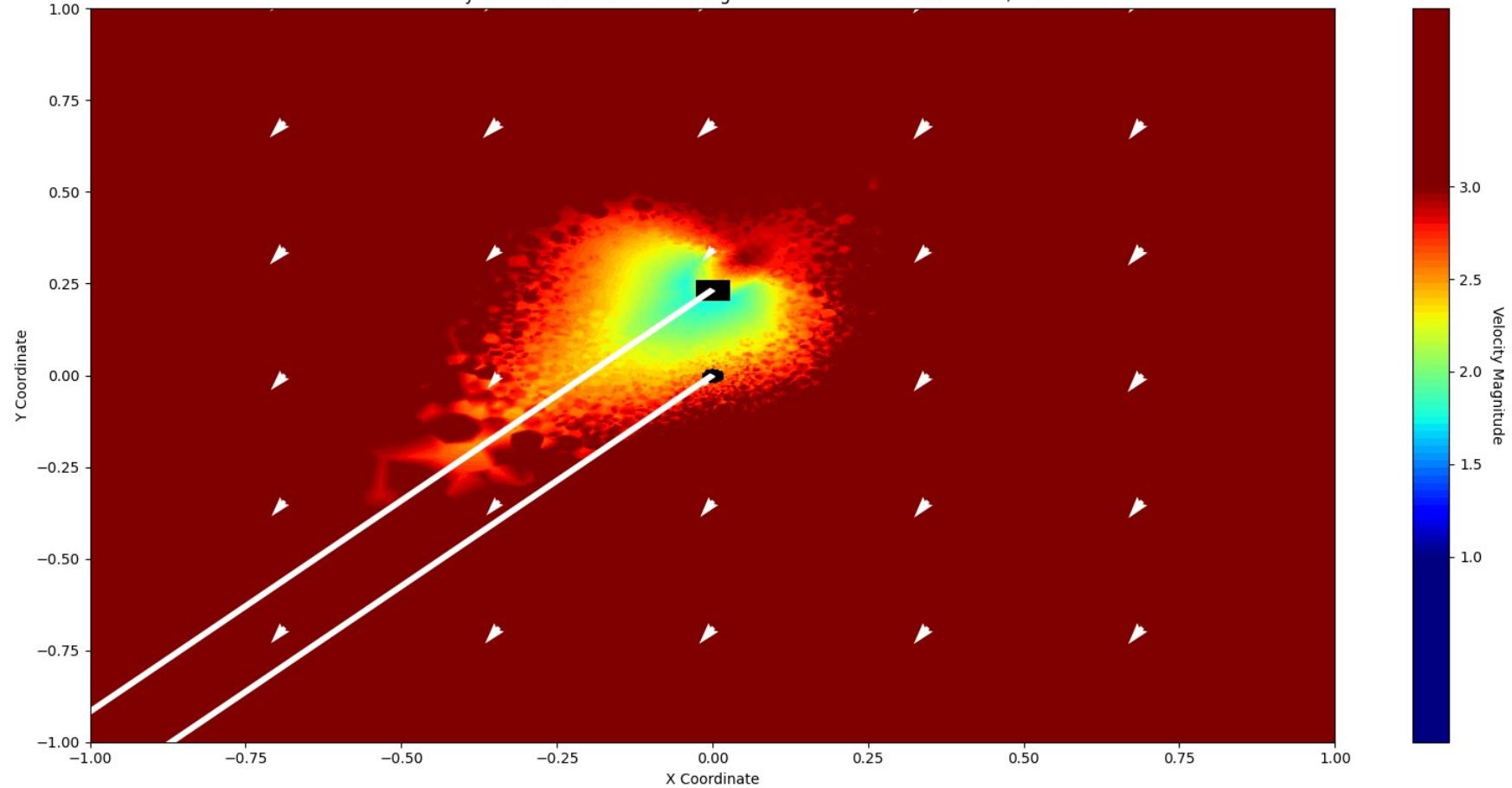
Total Velocity in the X-Y Plane for Wind Angle = 39 with a cut at Z = 0.17 +/- 0.02



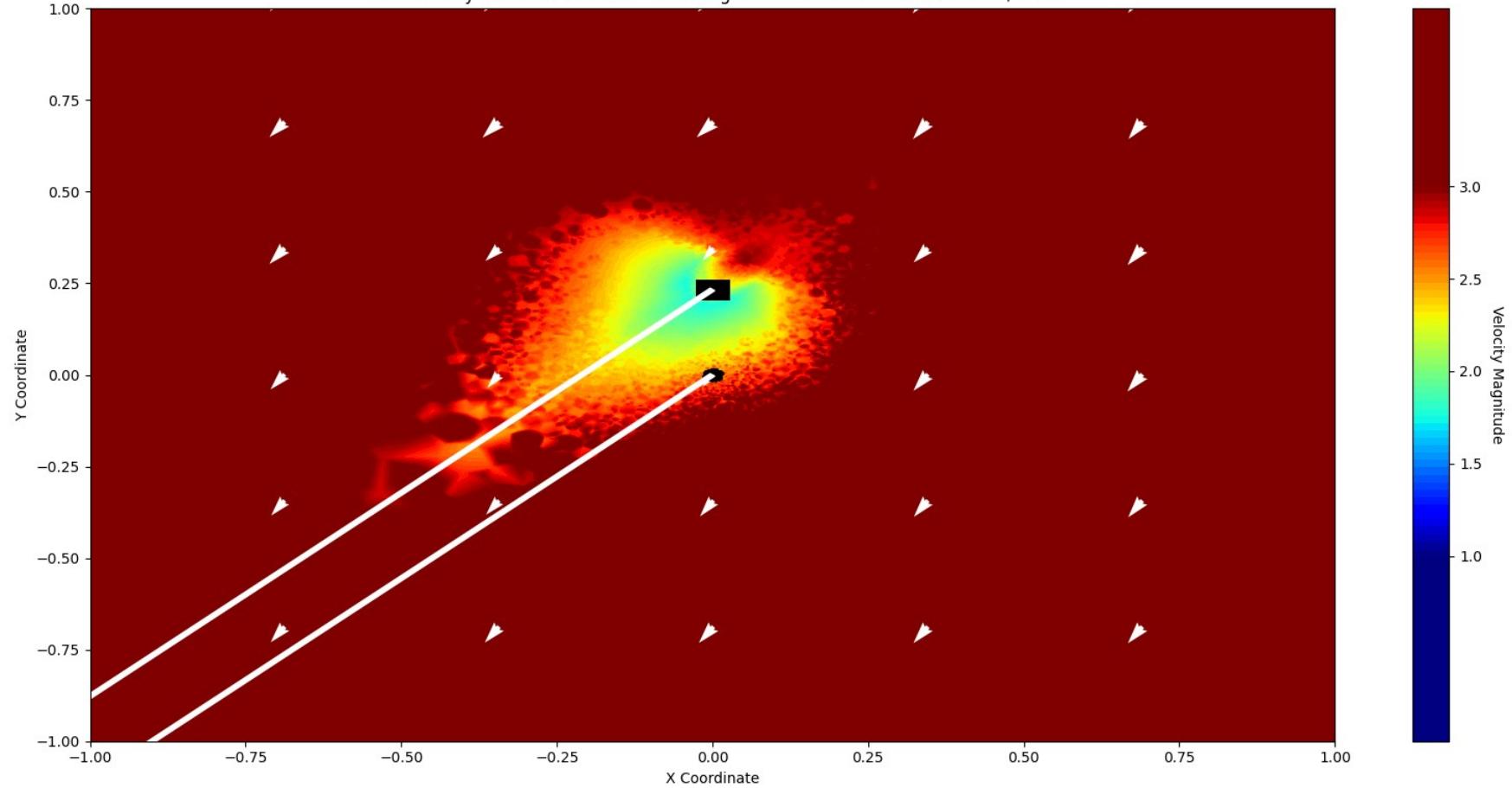
Total Velocity in the X-Y Plane for Wind Angle = 40 with a cut at Z = 0.17 +/- 0.02



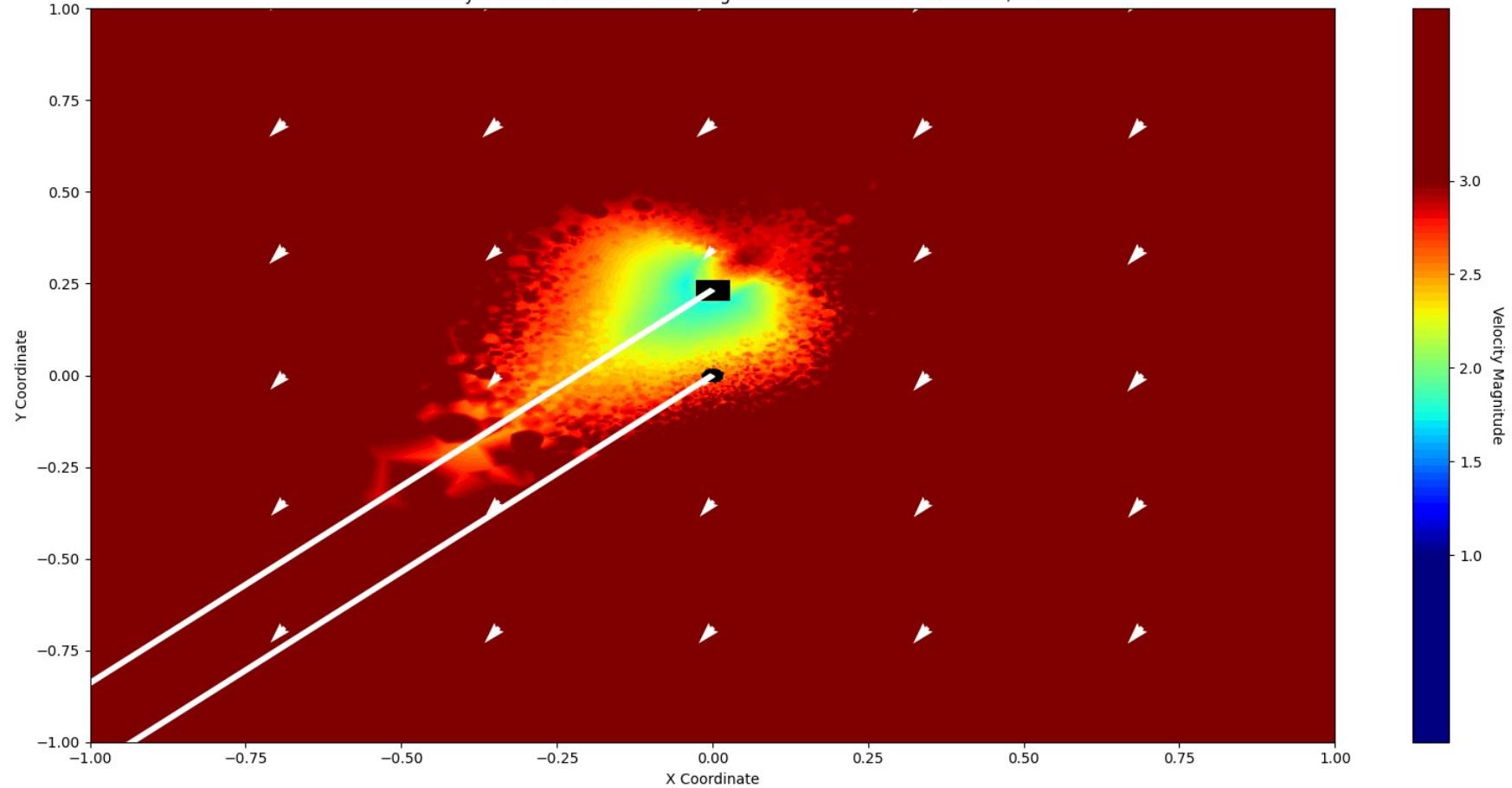
Total Velocity in the X-Y Plane for Wind Angle = 41 with a cut at Z = 0.17 +/- 0.02



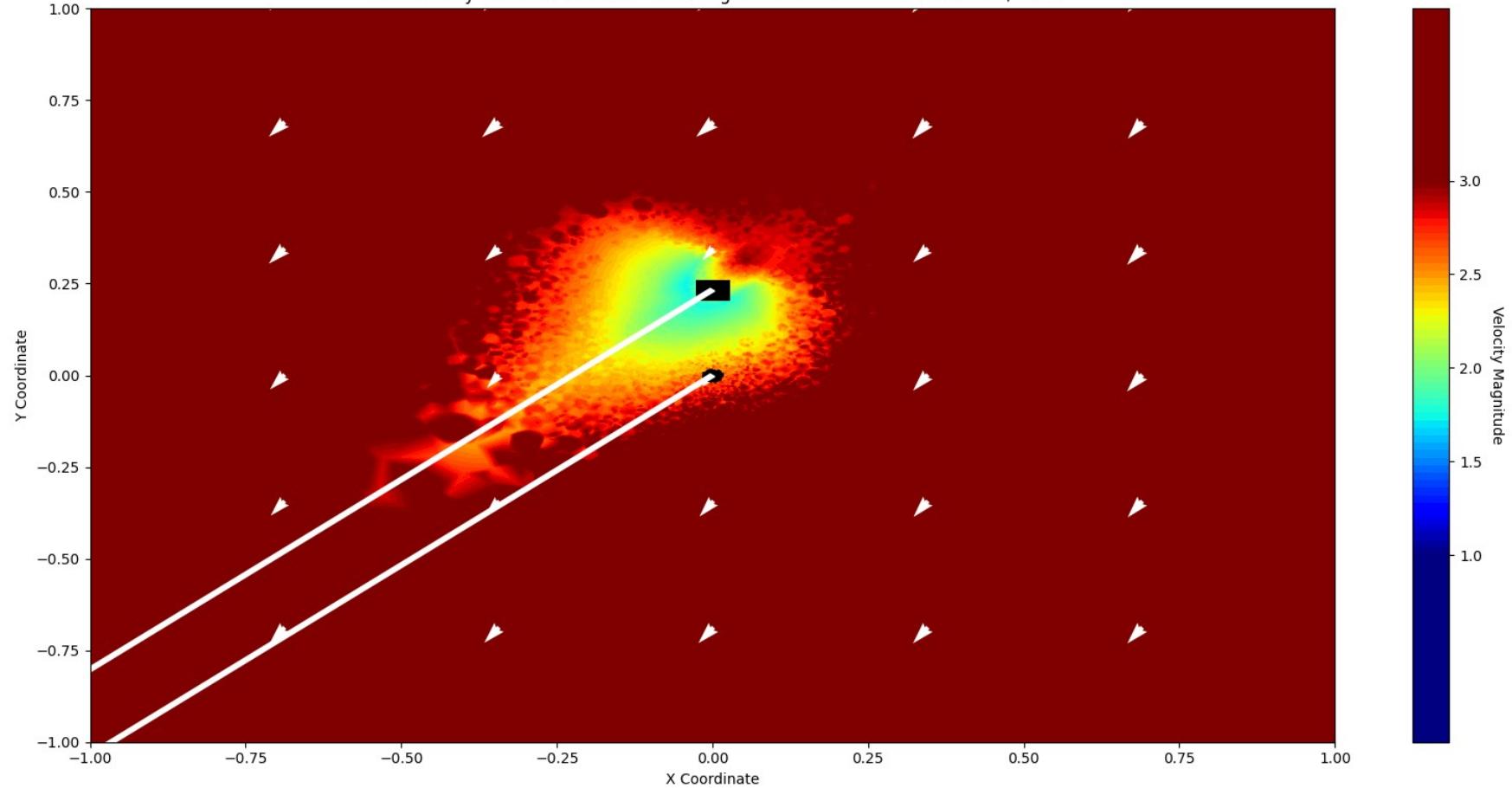
Total Velocity in the X-Y Plane for Wind Angle = 42 with a cut at Z = 0.17 +/- 0.02



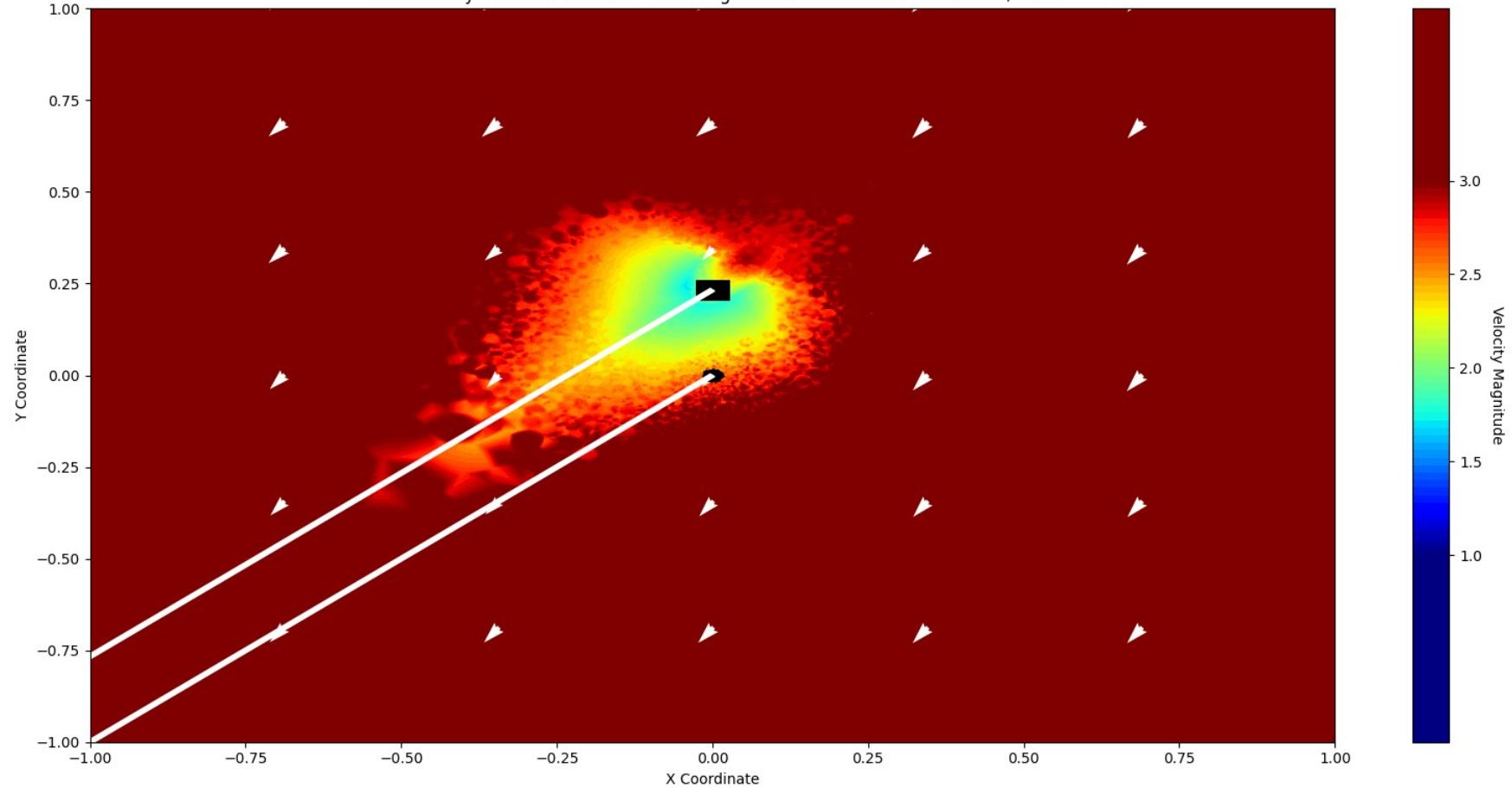
Total Velocity in the X-Y Plane for Wind Angle = 43 with a cut at Z = 0.17 +/- 0.02



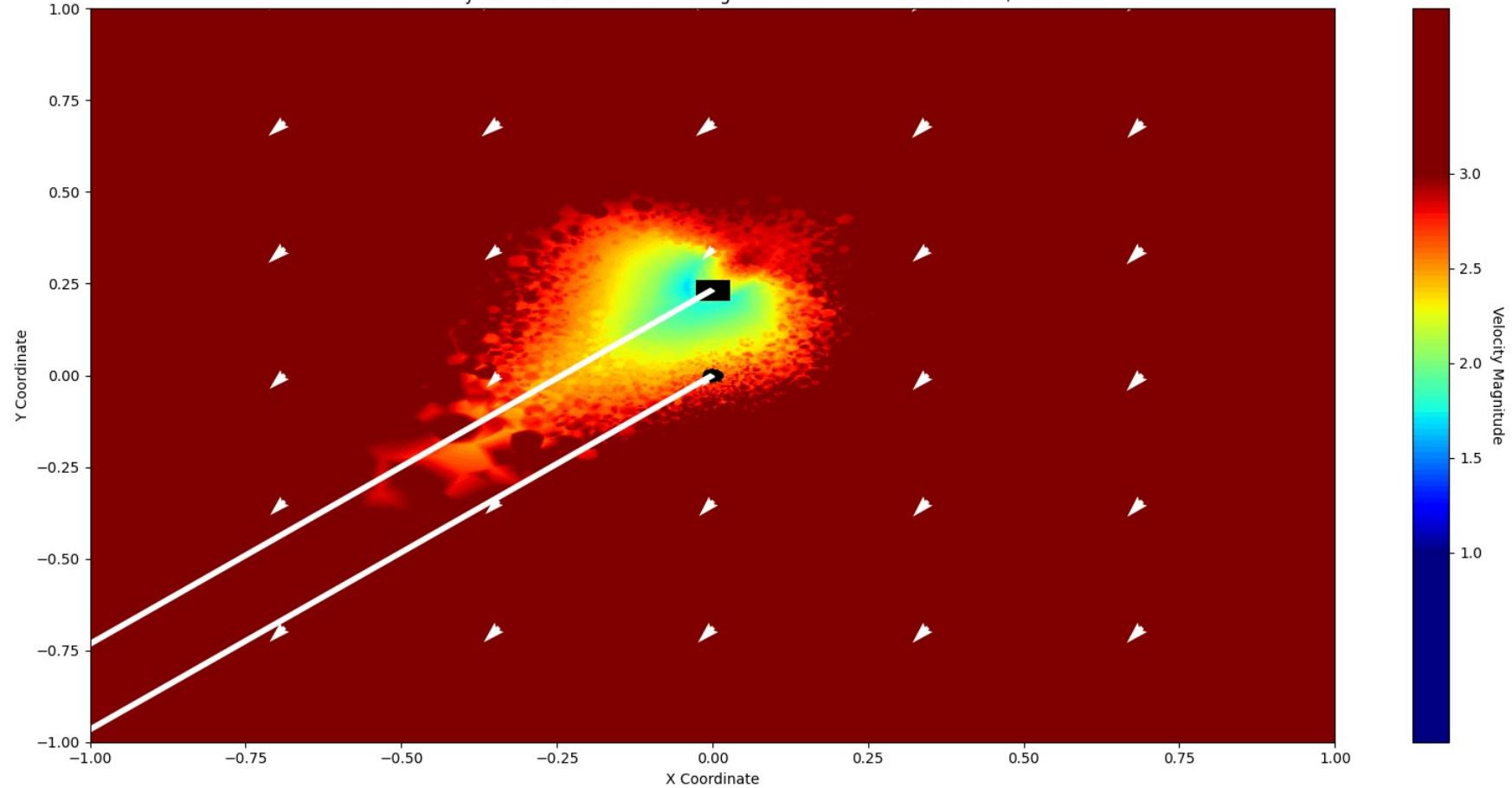
Total Velocity in the X-Y Plane for Wind Angle = 44 with a cut at Z = 0.17 +/- 0.02



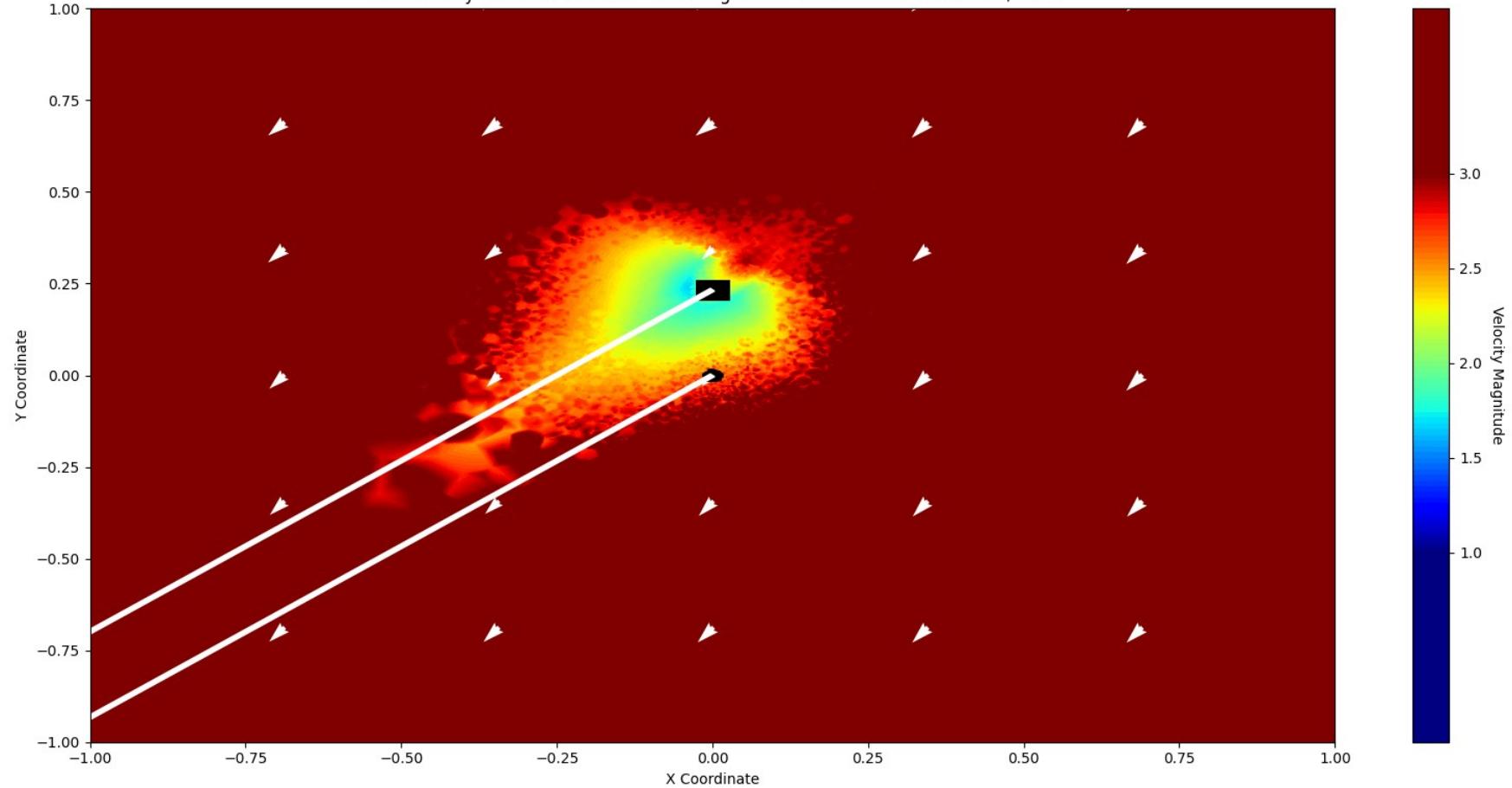
Total Velocity in the X-Y Plane for Wind Angle = 45 with a cut at Z = 0.17 +/- 0.02



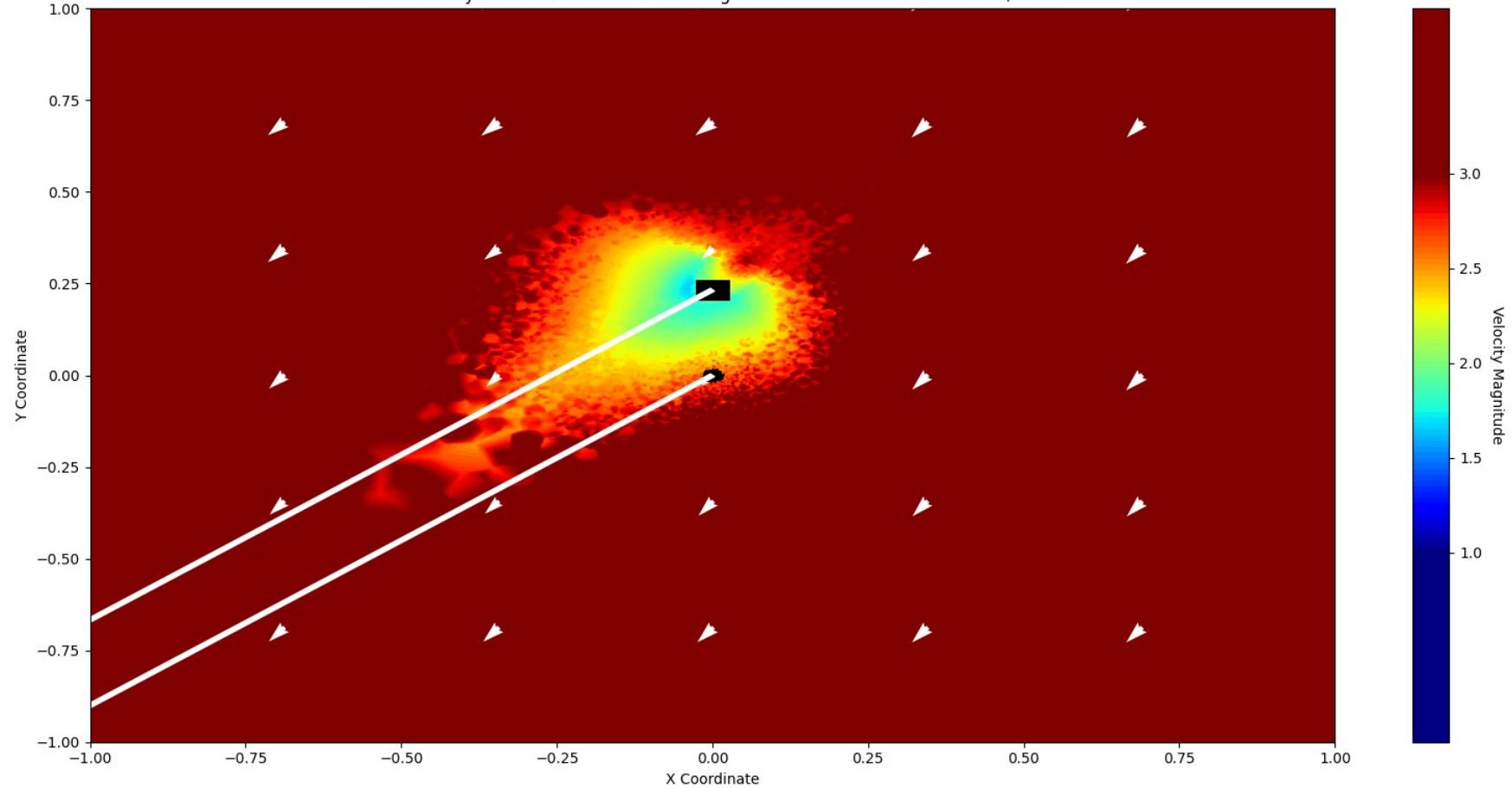
Total Velocity in the X-Y Plane for Wind Angle = 46 with a cut at Z = 0.17 +/- 0.02



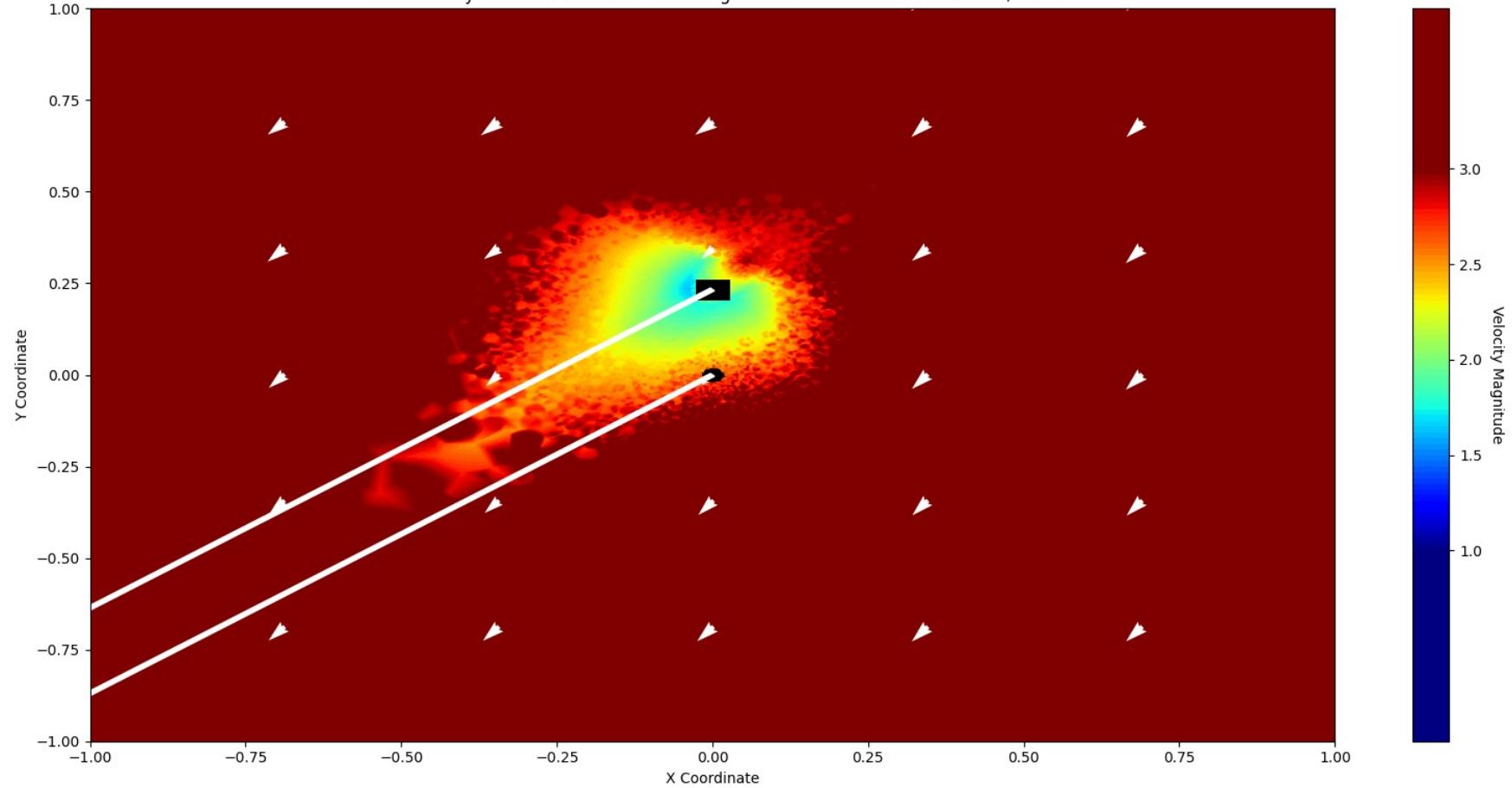
Total Velocity in the X-Y Plane for Wind Angle = 47 with a cut at Z = 0.17 +/- 0.02



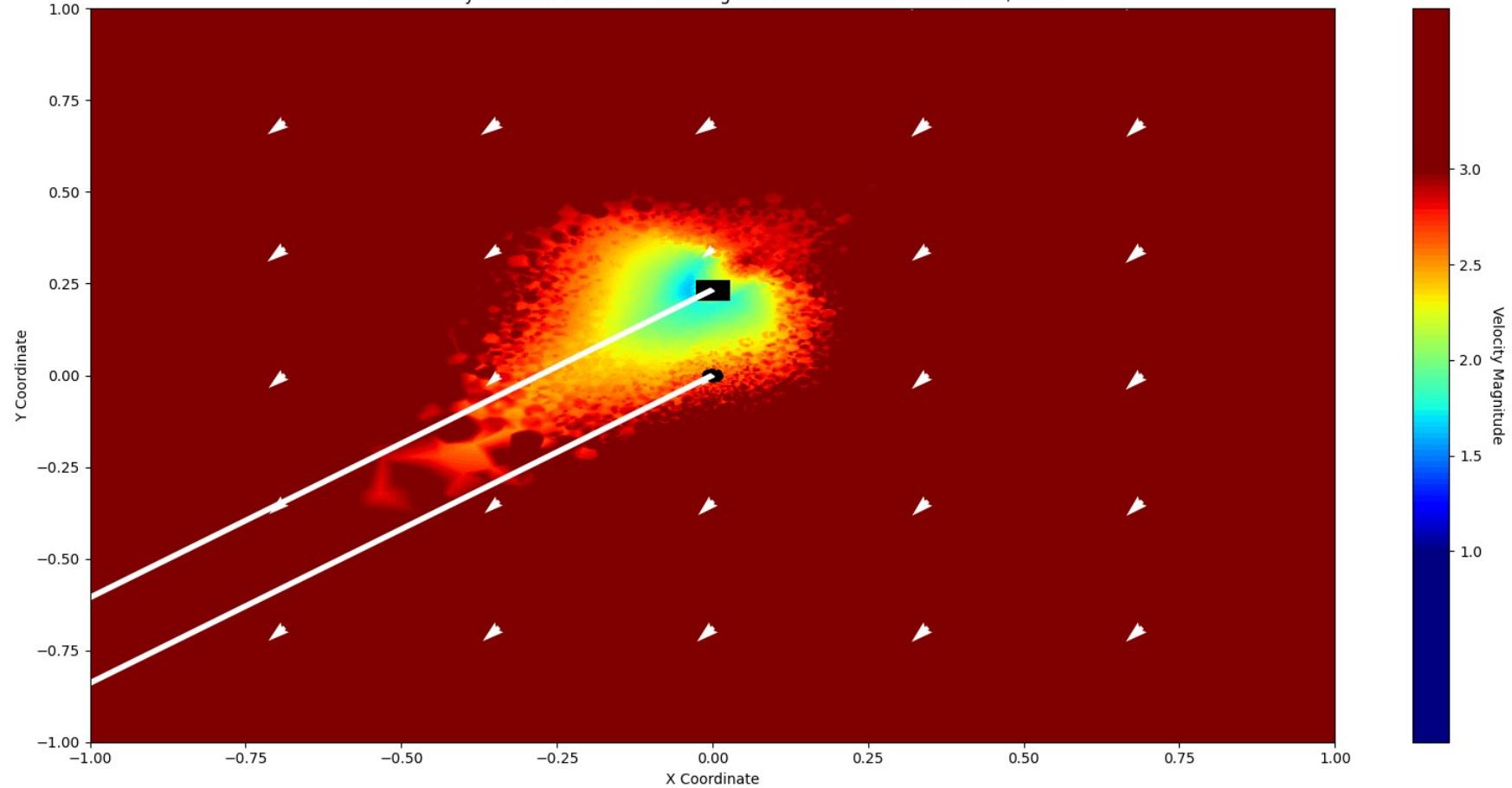
Total Velocity in the X-Y Plane for Wind Angle = 48 with a cut at Z = 0.17 +/- 0.02



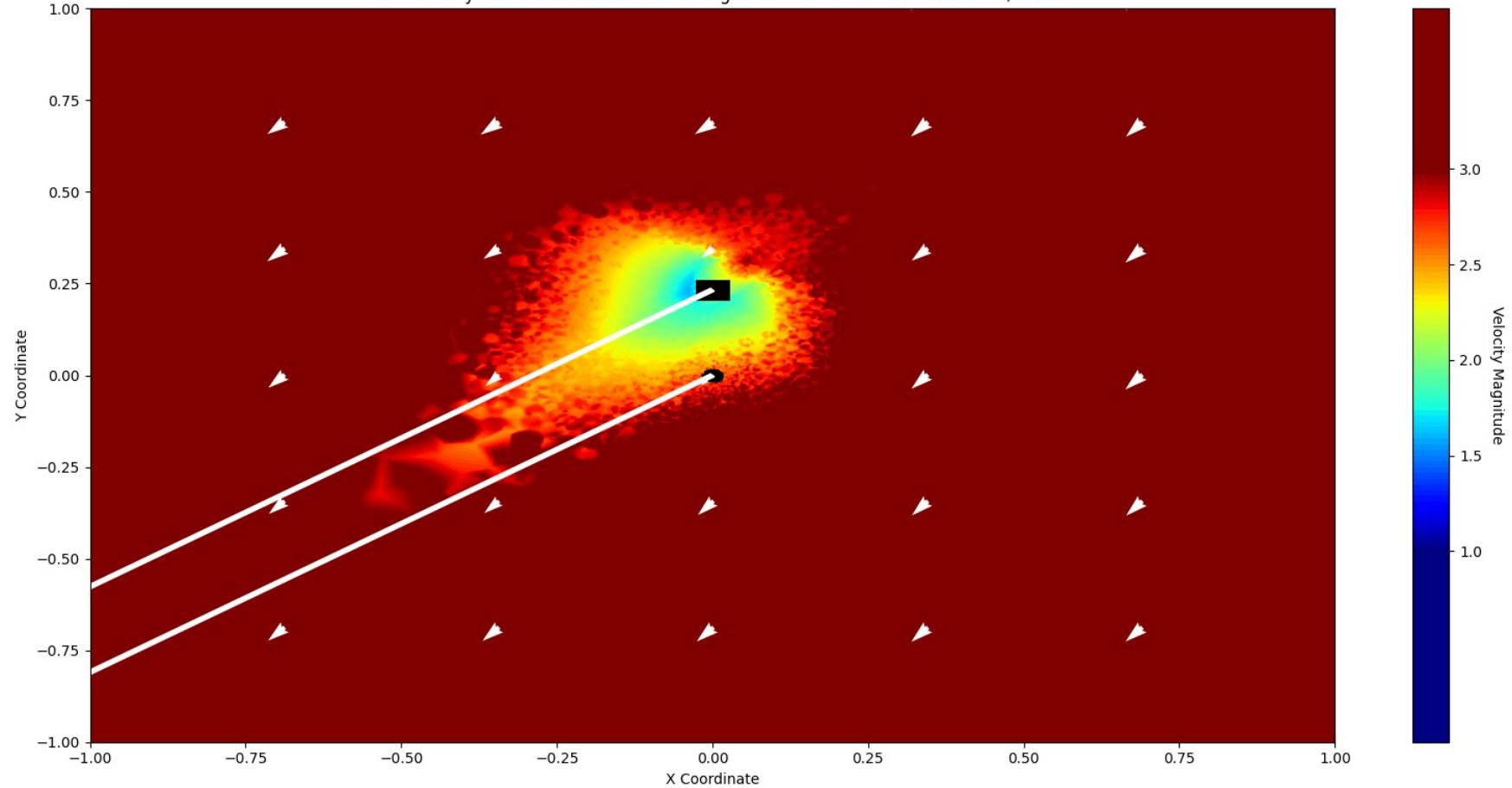
Total Velocity in the X-Y Plane for Wind Angle = 49 with a cut at Z = 0.17 +/- 0.02



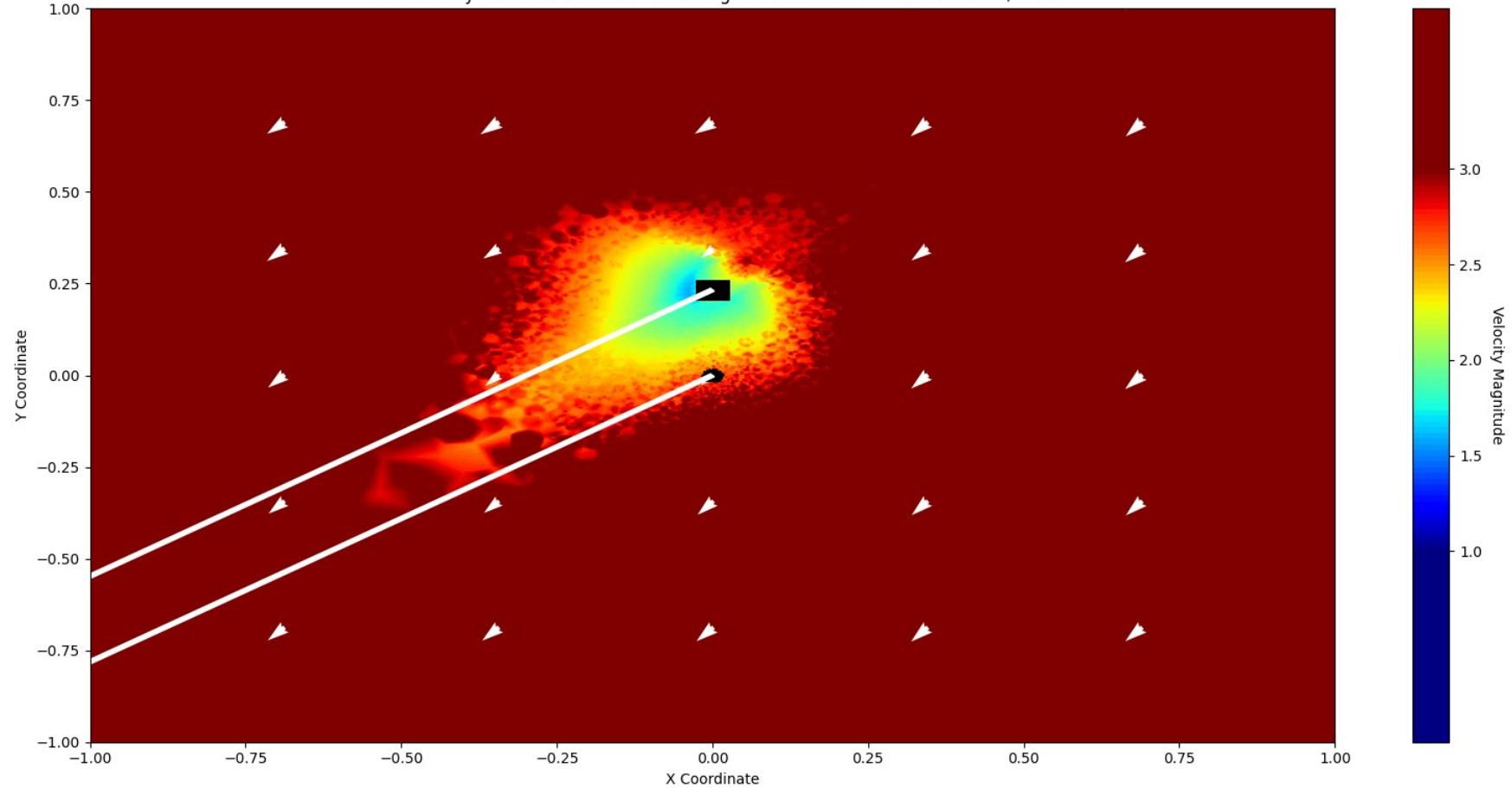
Total Velocity in the X-Y Plane for Wind Angle = 50 with a cut at Z = 0.17 +/- 0.02



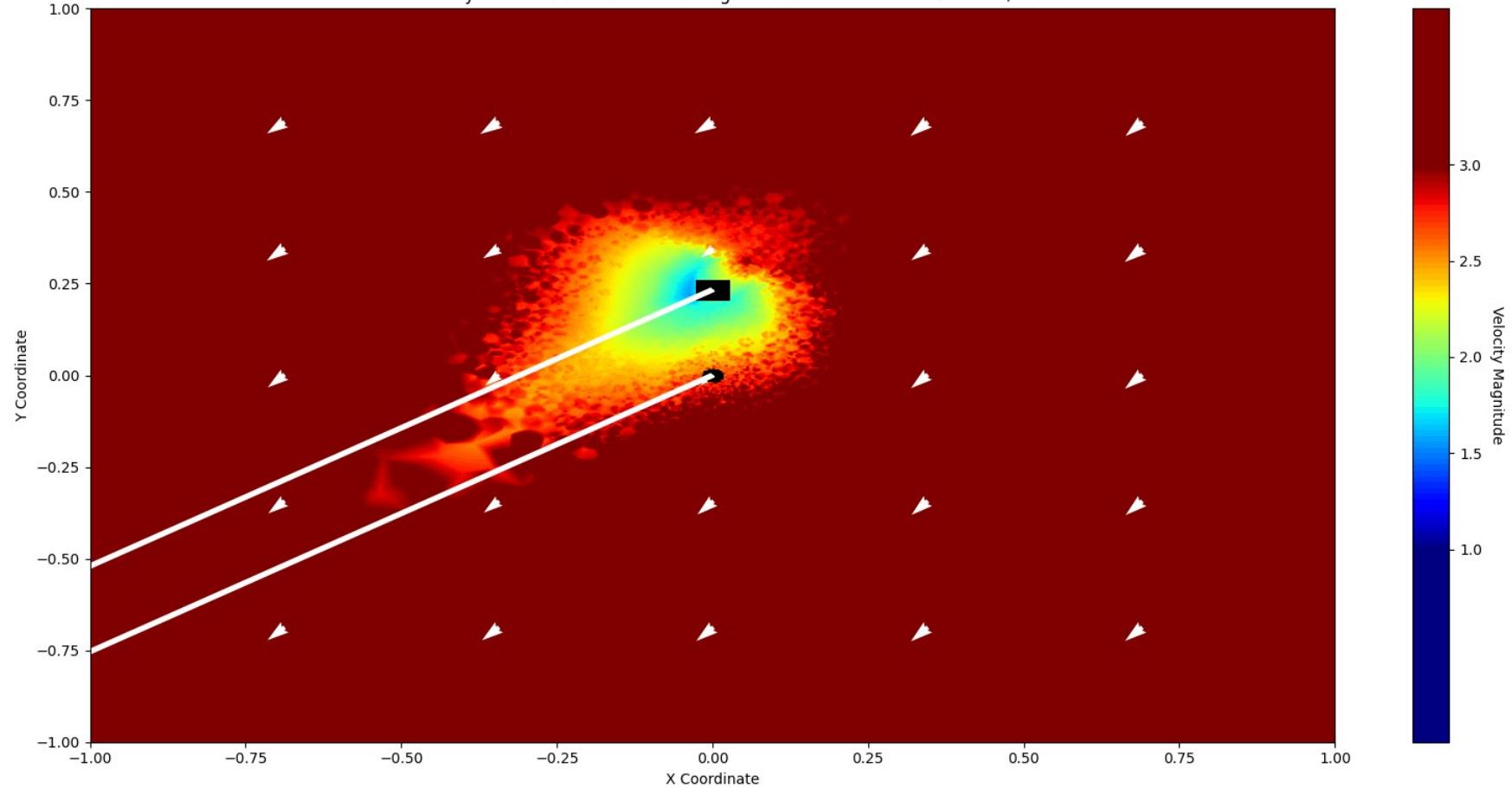
Total Velocity in the X-Y Plane for Wind Angle = 51 with a cut at Z = 0.17 +/- 0.02



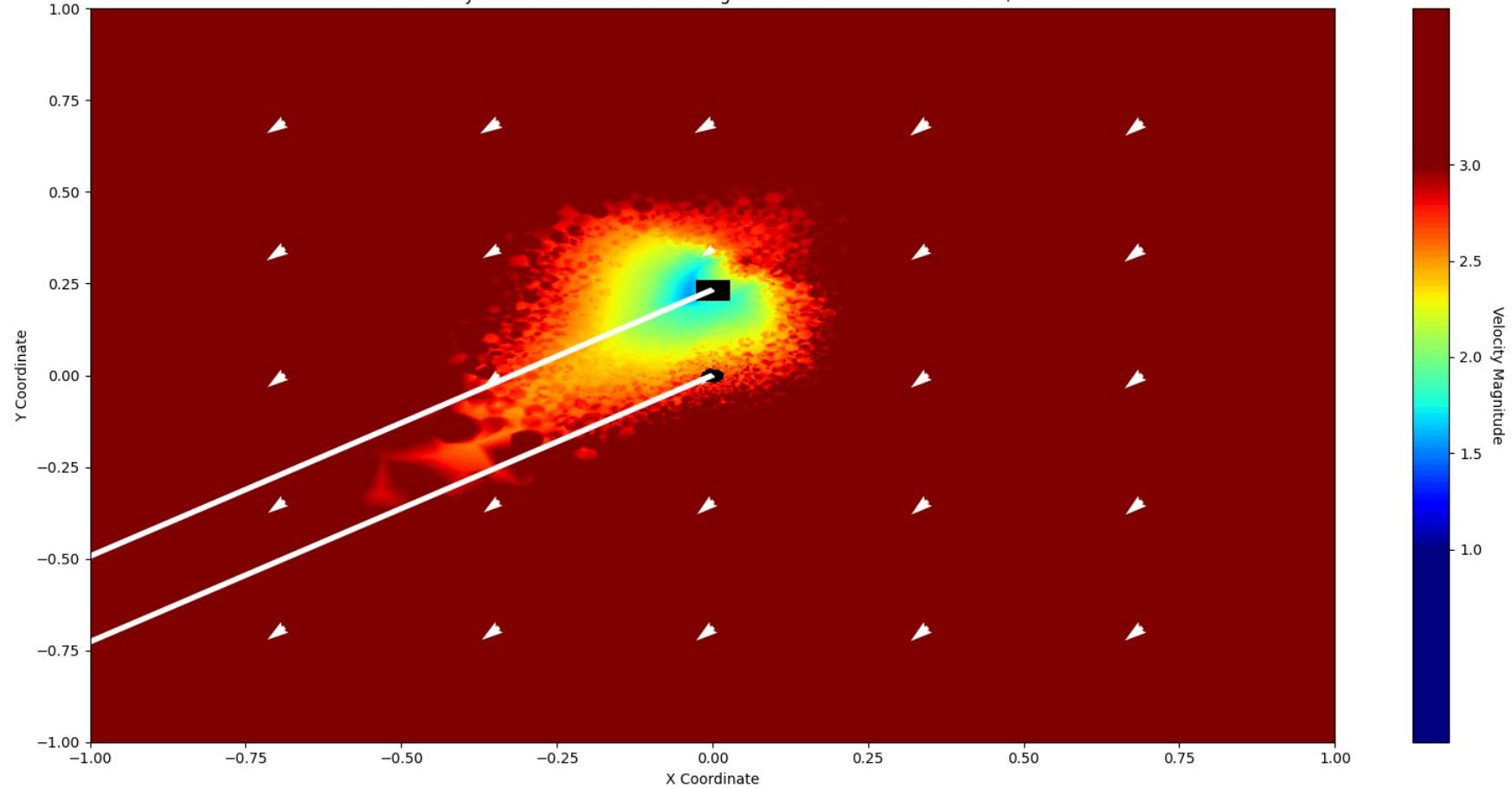
Total Velocity in the X-Y Plane for Wind Angle = 52 with a cut at Z = 0.17 +/- 0.02



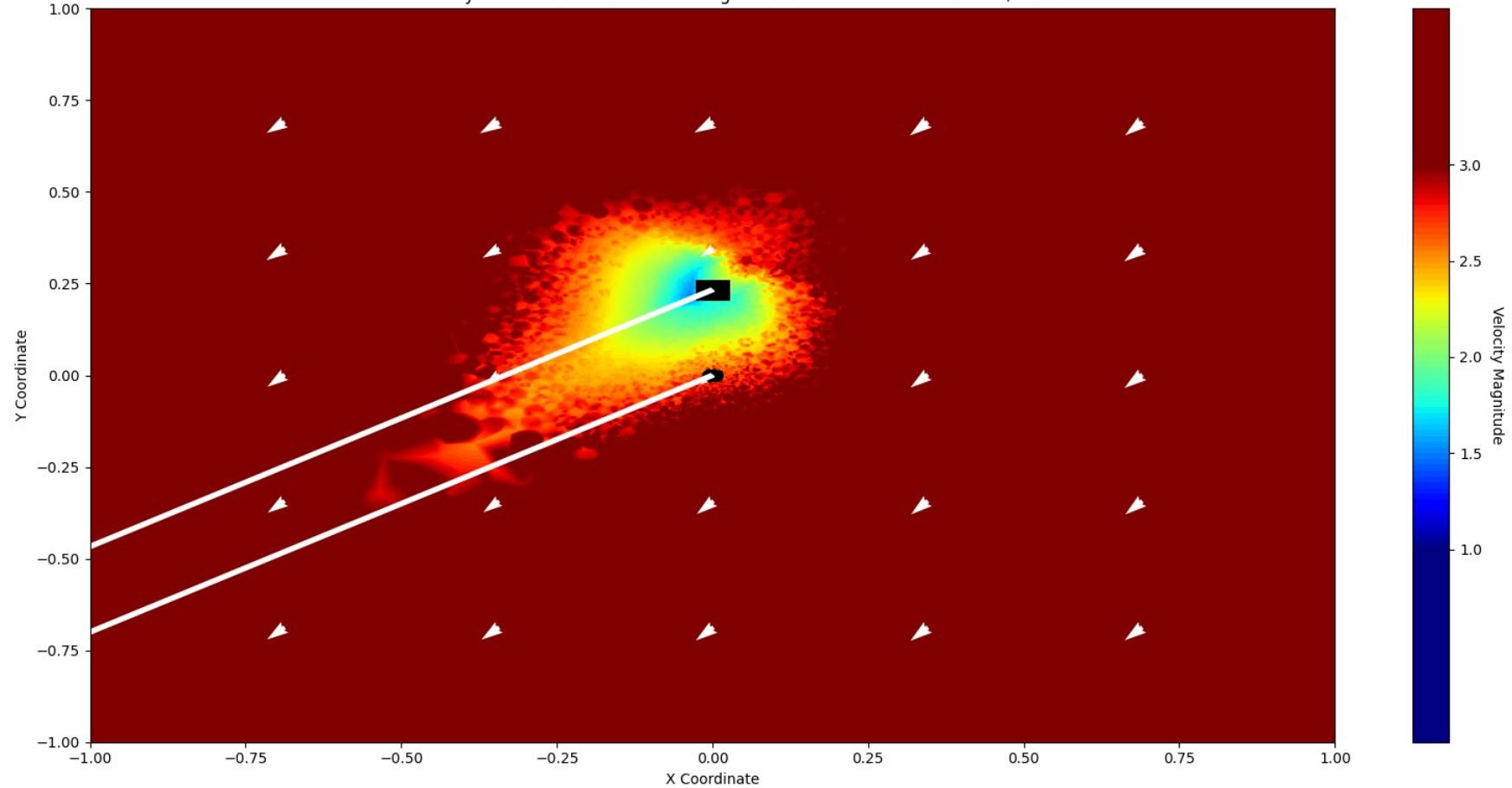
Total Velocity in the X-Y Plane for Wind Angle = 53 with a cut at Z = 0.17 +/- 0.02



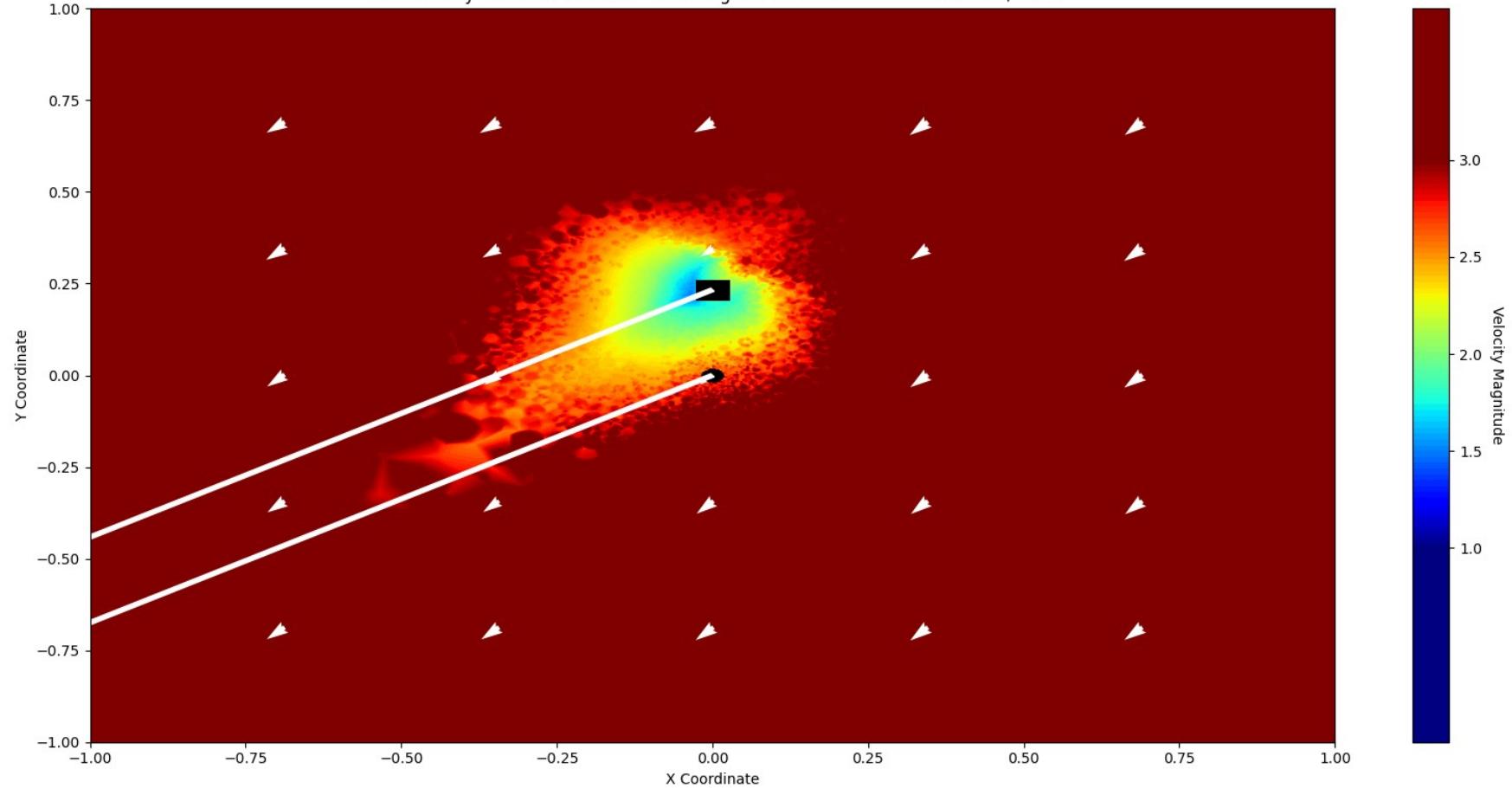
Total Velocity in the X-Y Plane for Wind Angle = 54 with a cut at Z = 0.17 +/- 0.02



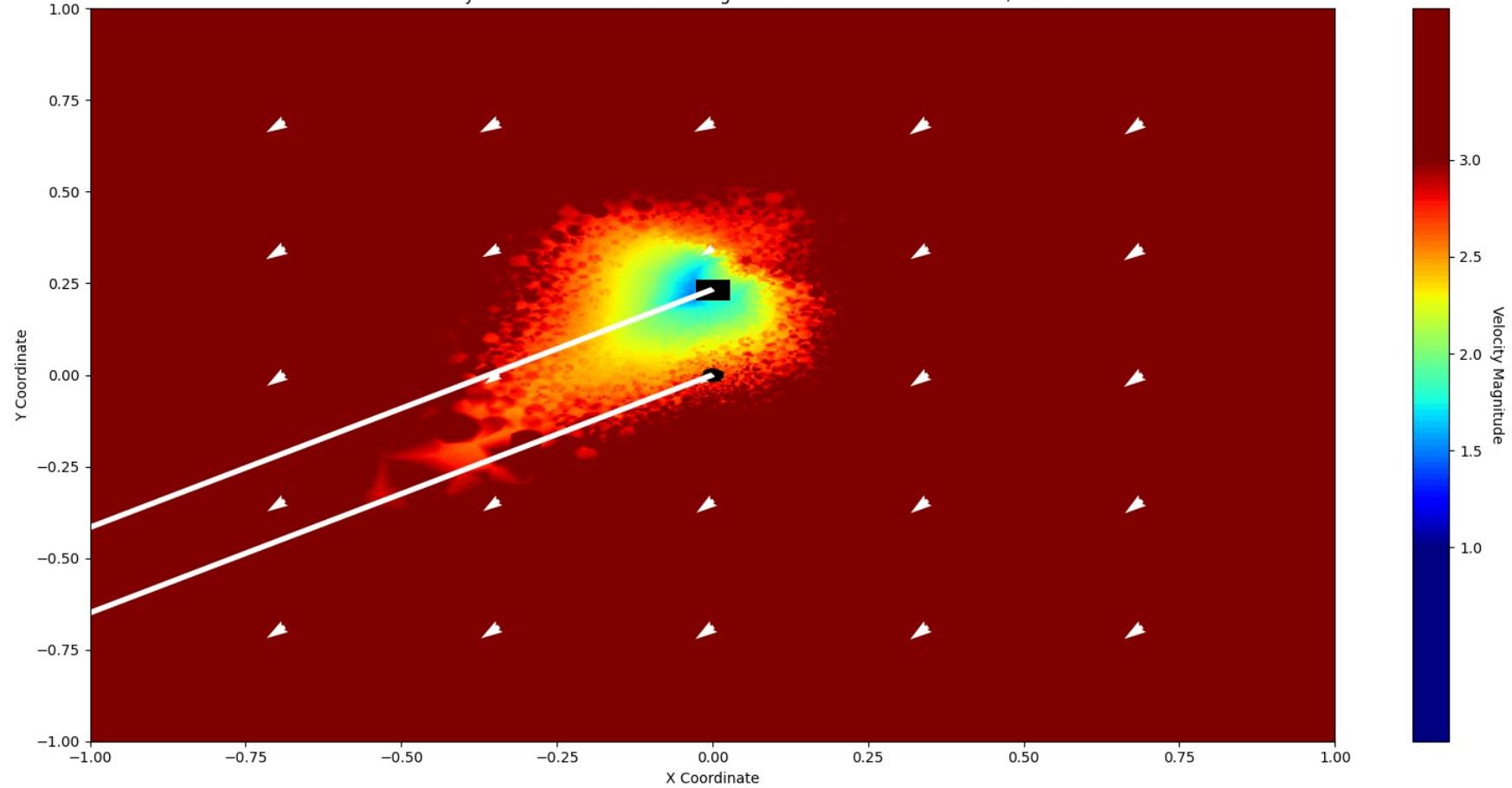
Total Velocity in the X-Y Plane for Wind Angle = 55 with a cut at Z = 0.17 +/- 0.02



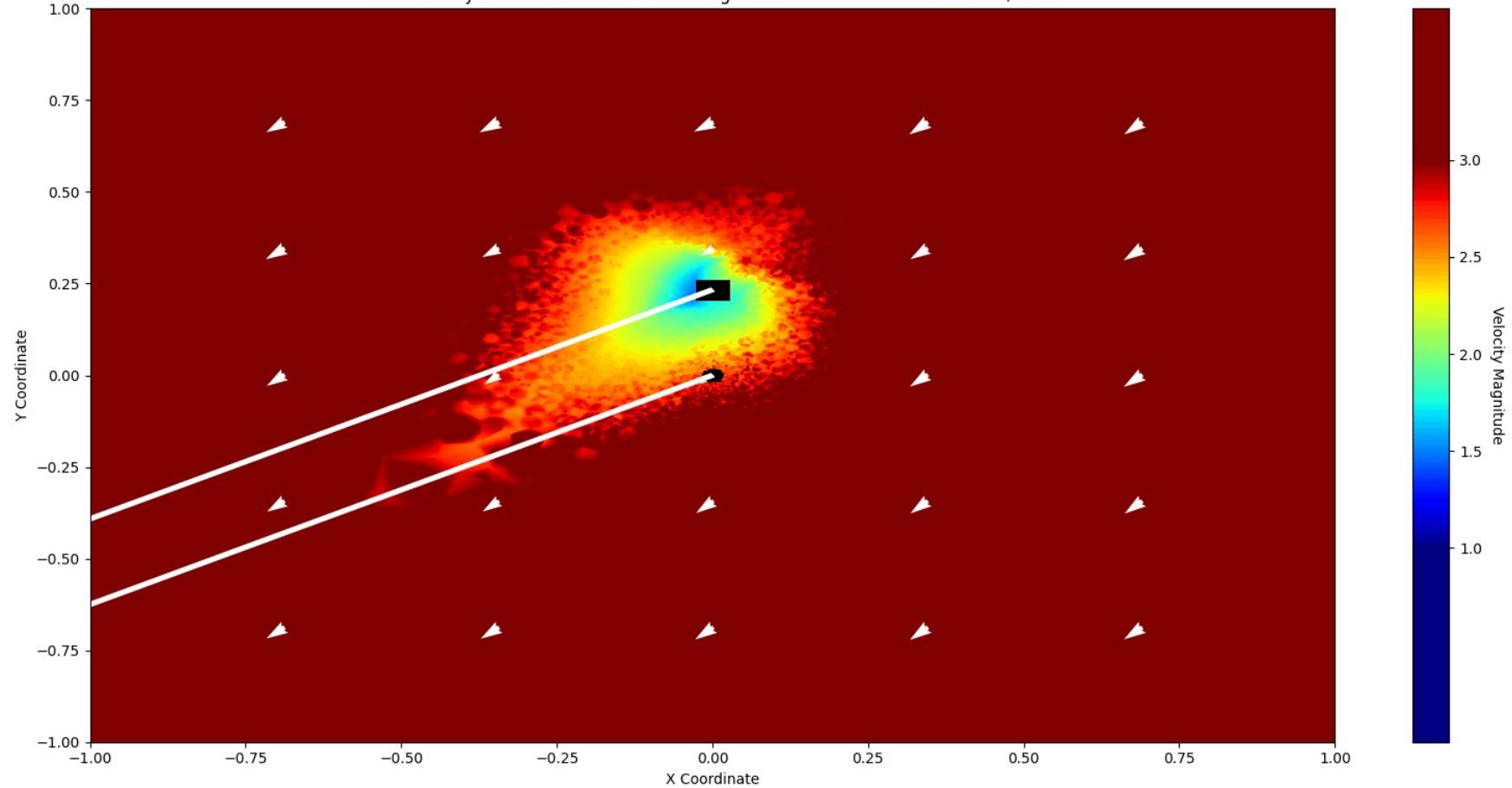
Total Velocity in the X-Y Plane for Wind Angle = 56 with a cut at Z = 0.17 +/- 0.02



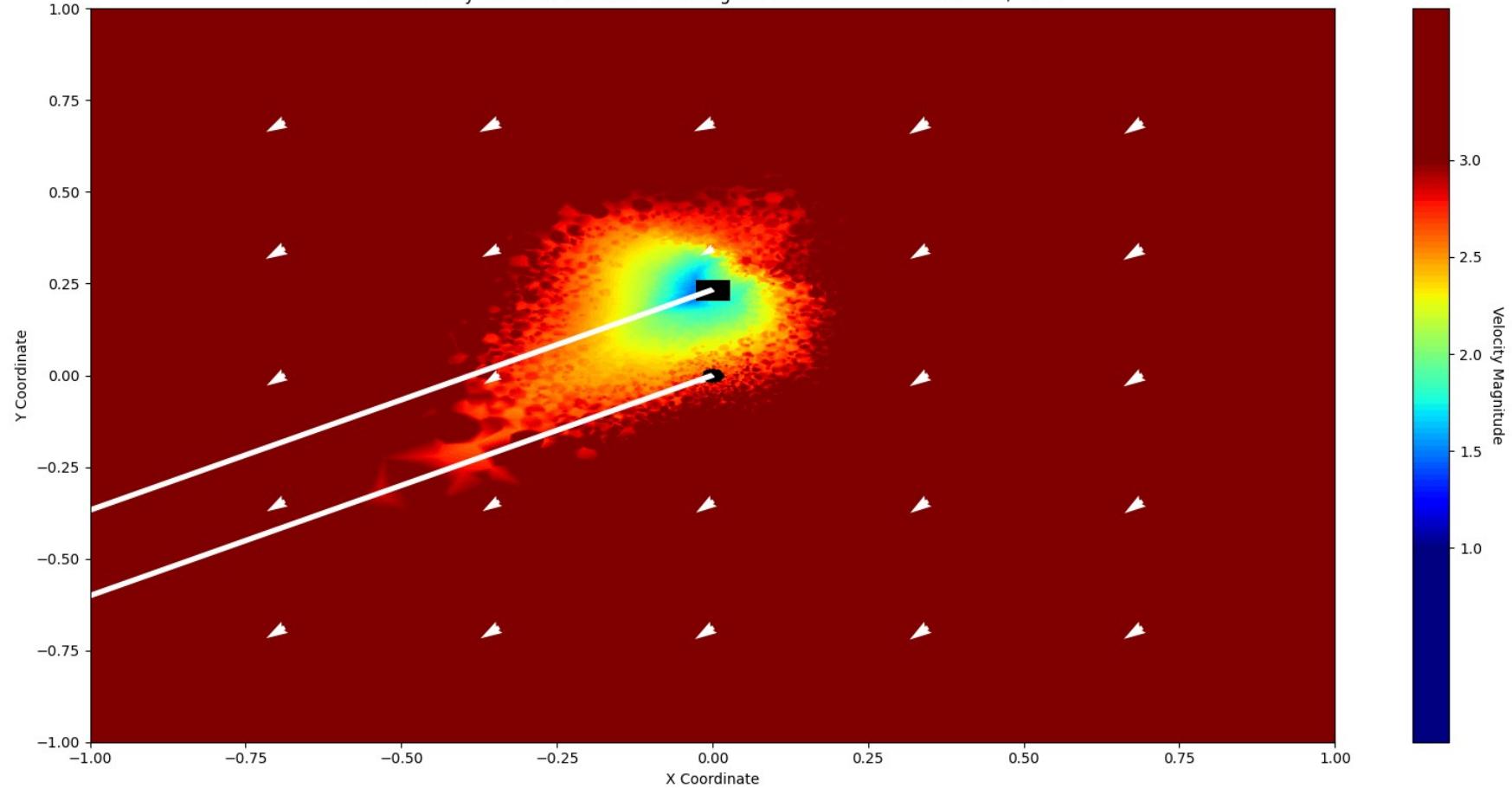
Total Velocity in the X-Y Plane for Wind Angle = 57 with a cut at Z = 0.17 +/- 0.02



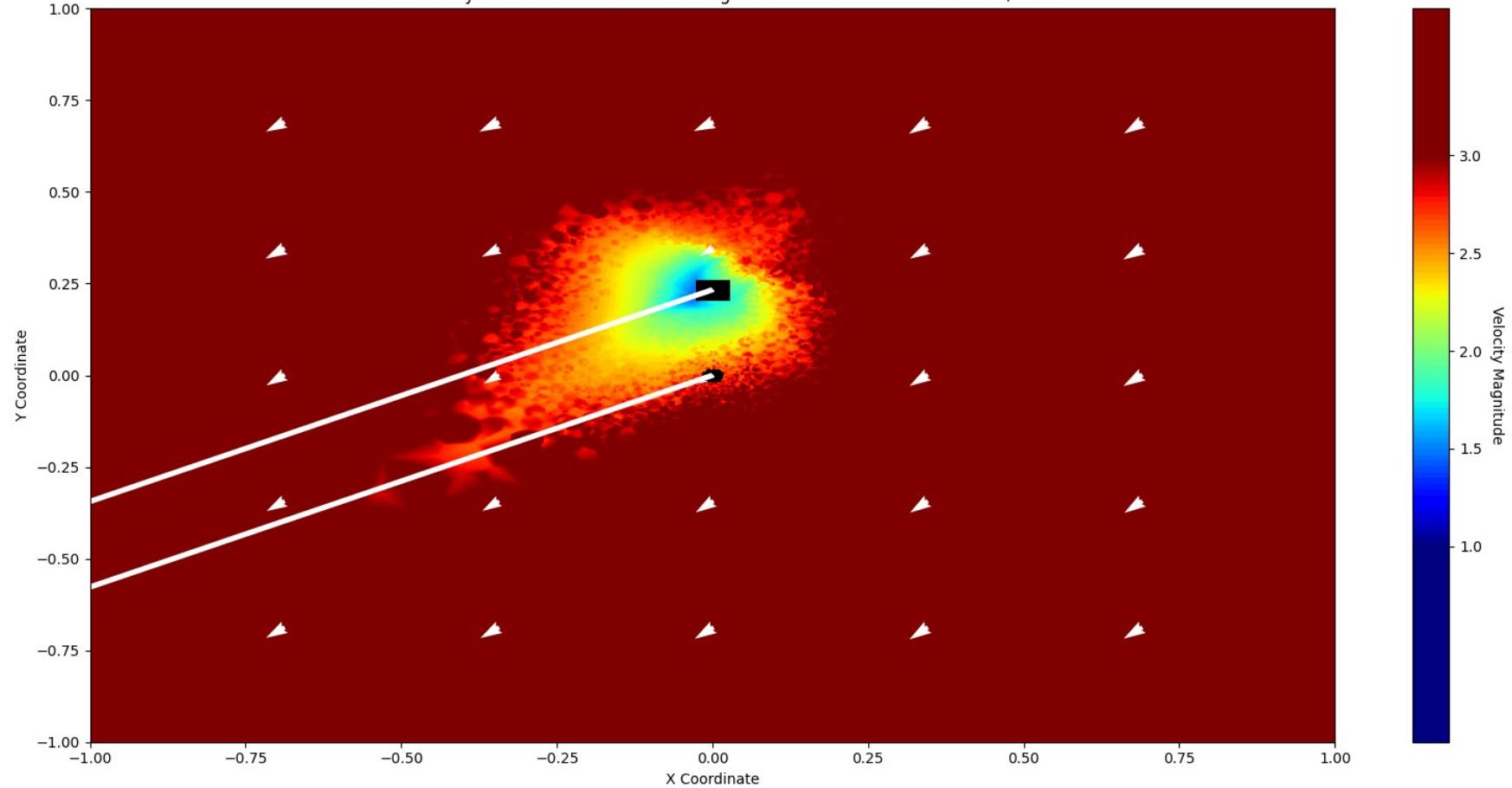
Total Velocity in the X-Y Plane for Wind Angle = 58 with a cut at Z = 0.17 +/- 0.02



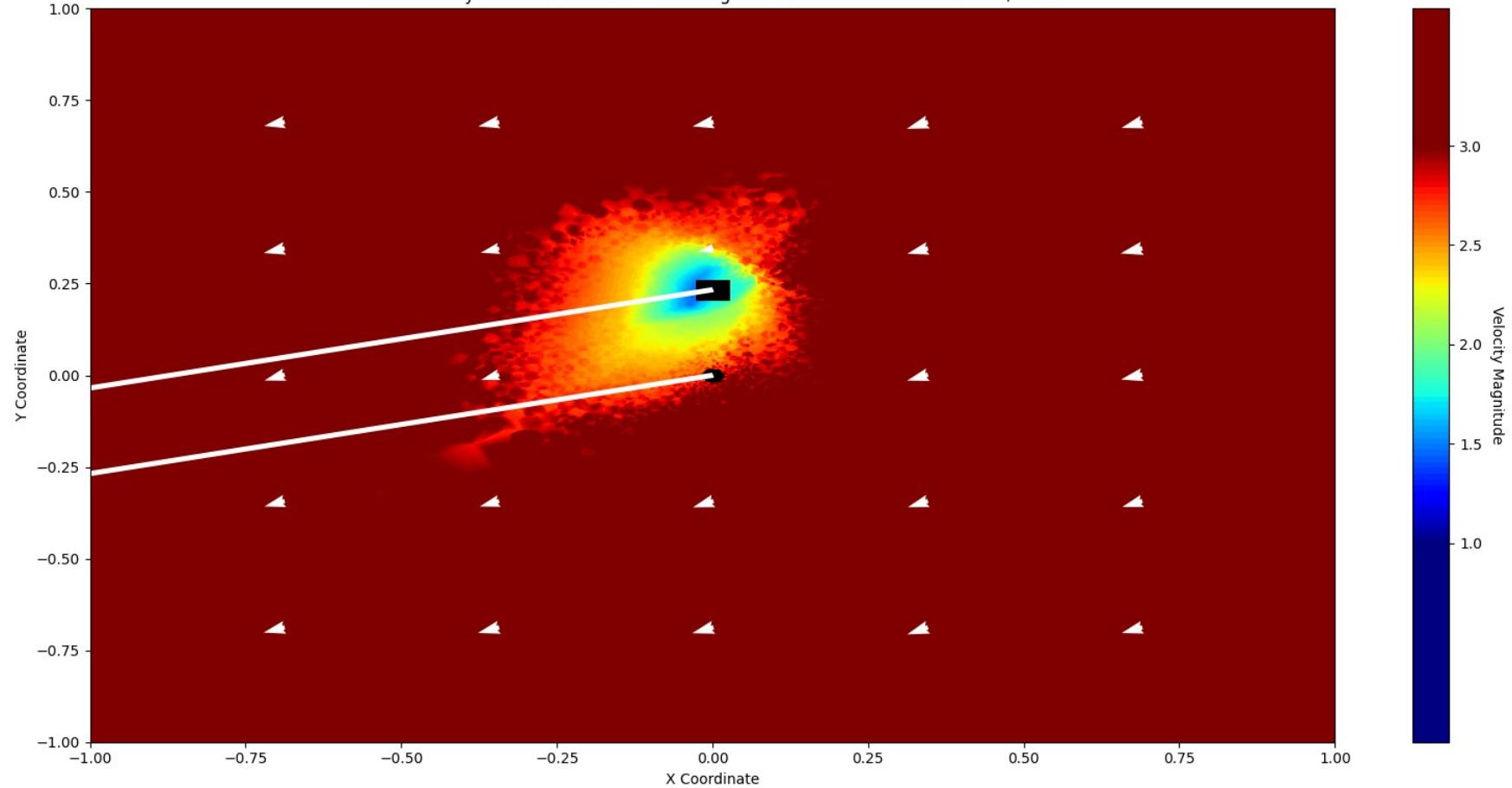
Total Velocity in the X-Y Plane for Wind Angle = 59 with a cut at Z = 0.17 +/- 0.02



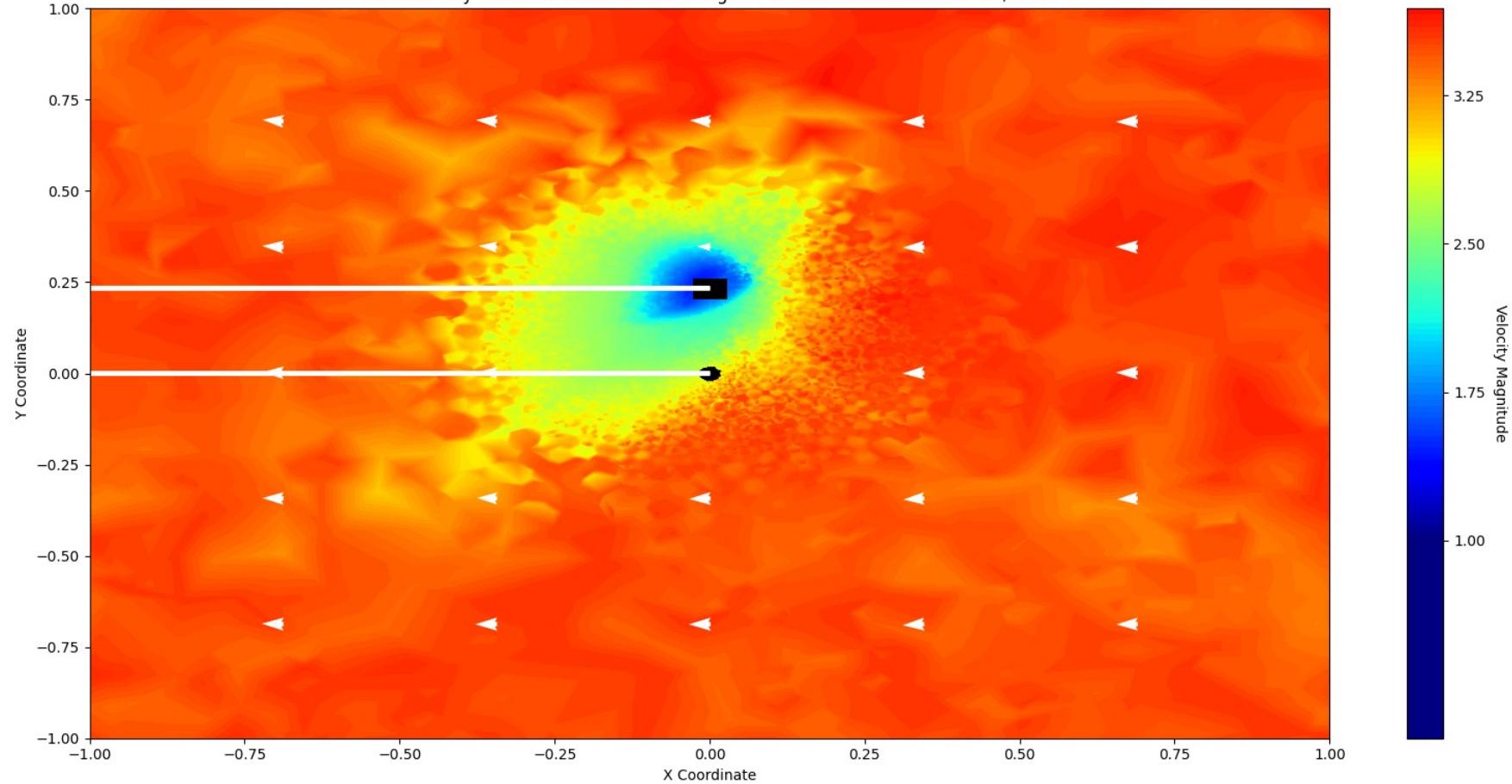
Total Velocity in the X-Y Plane for Wind Angle = 60 with a cut at Z = 0.17 +/- 0.02



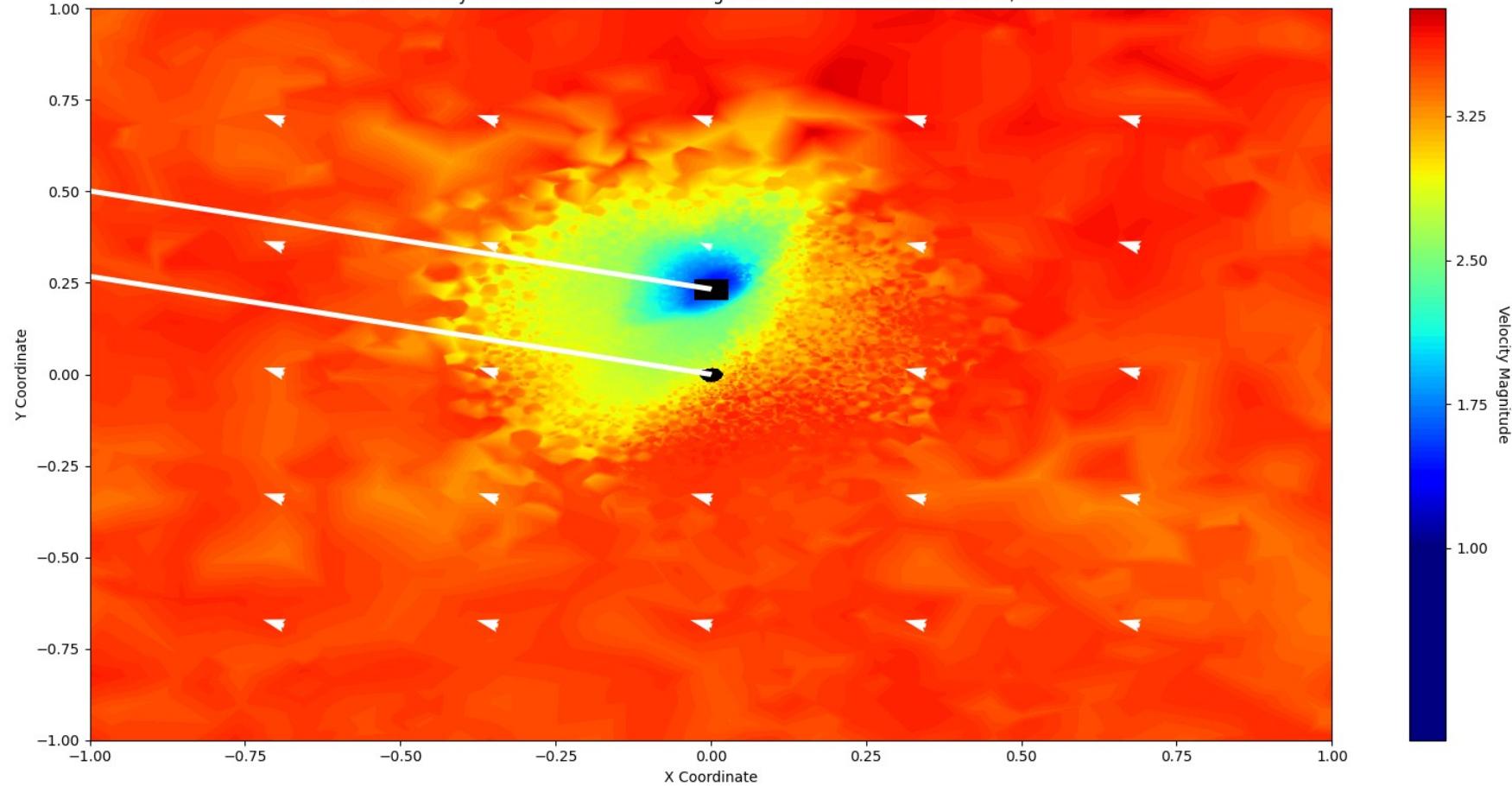
Total Velocity in the X-Y Plane for Wind Angle = 75 with a cut at Z = 0.17 +/- 0.02



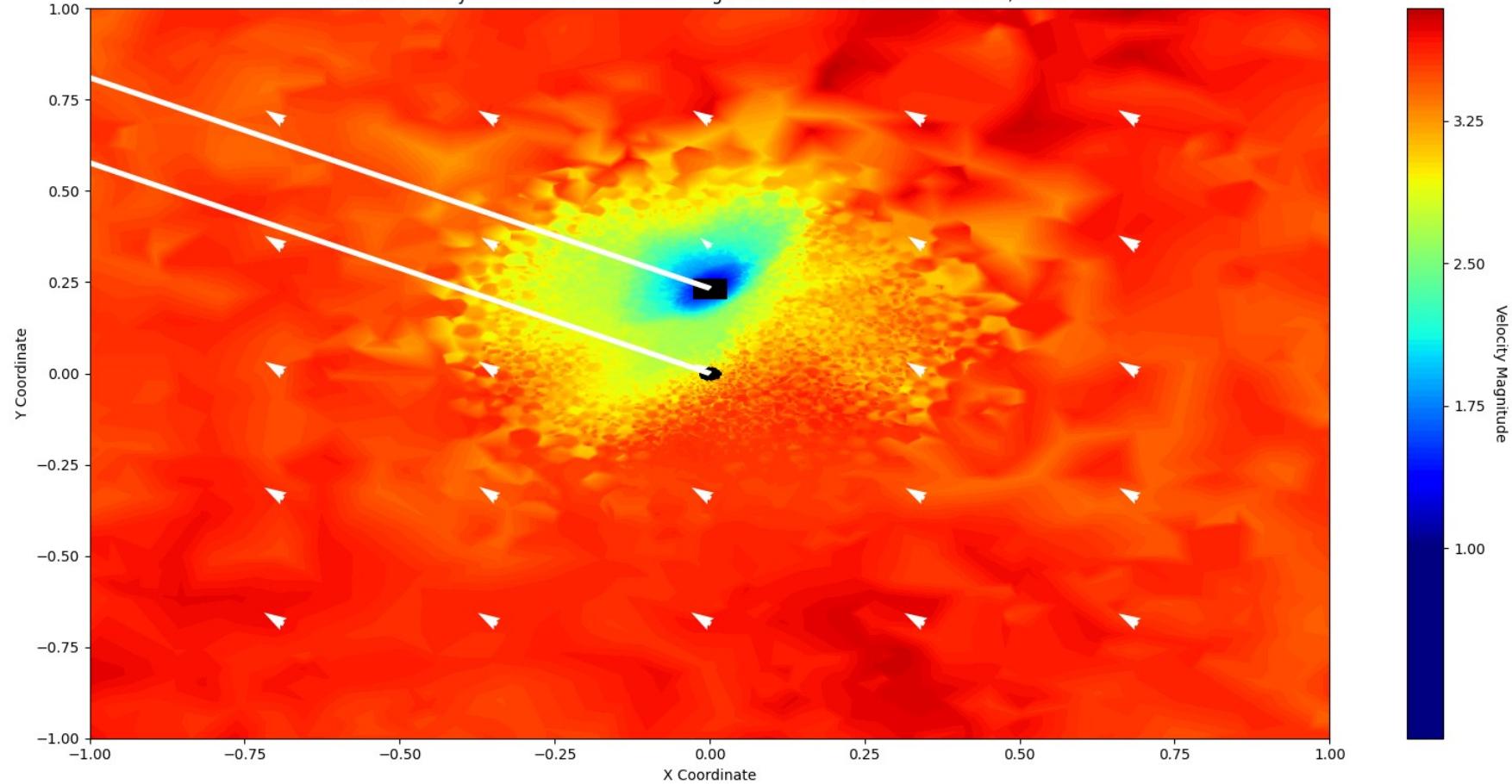
Total Velocity in the X-Y Plane for Wind Angle = 90 with a cut at Z = 0.17 +/- 0.02



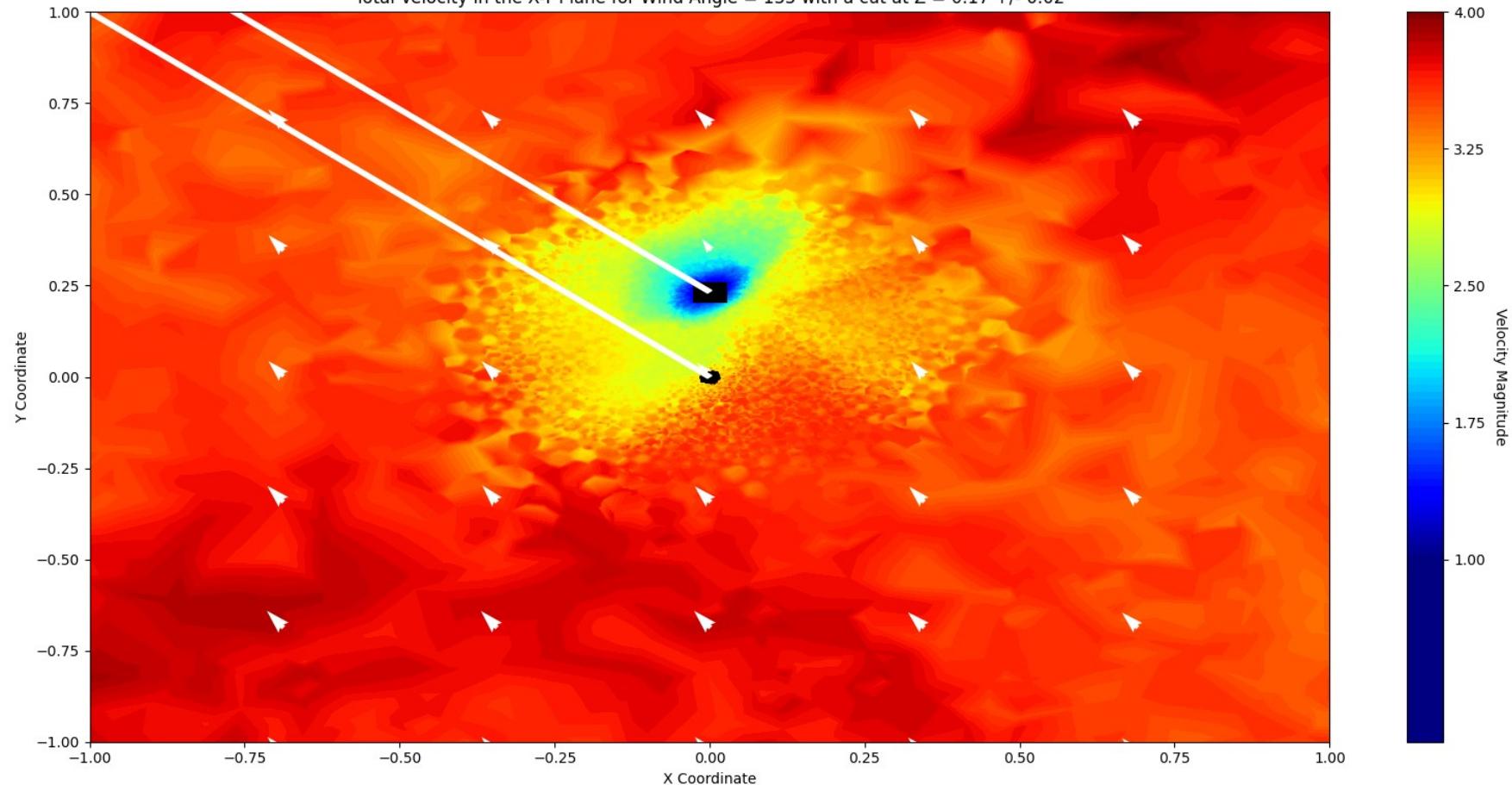
Total Velocity in the X-Y Plane for Wind Angle = 105 with a cut at Z = 0.17 +/- 0.02



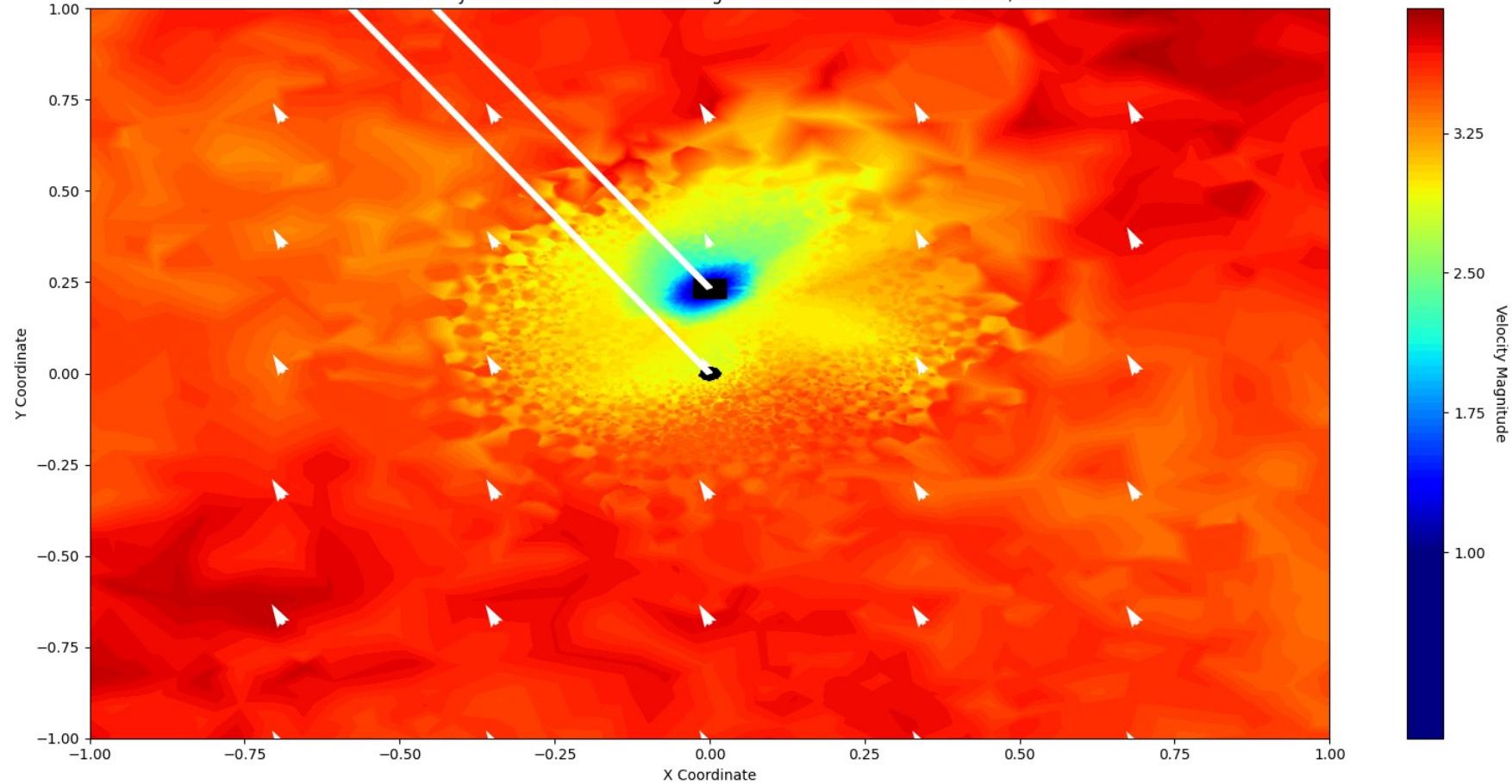
Total Velocity in the X-Y Plane for Wind Angle = 120 with a cut at Z = 0.17 +/- 0.02



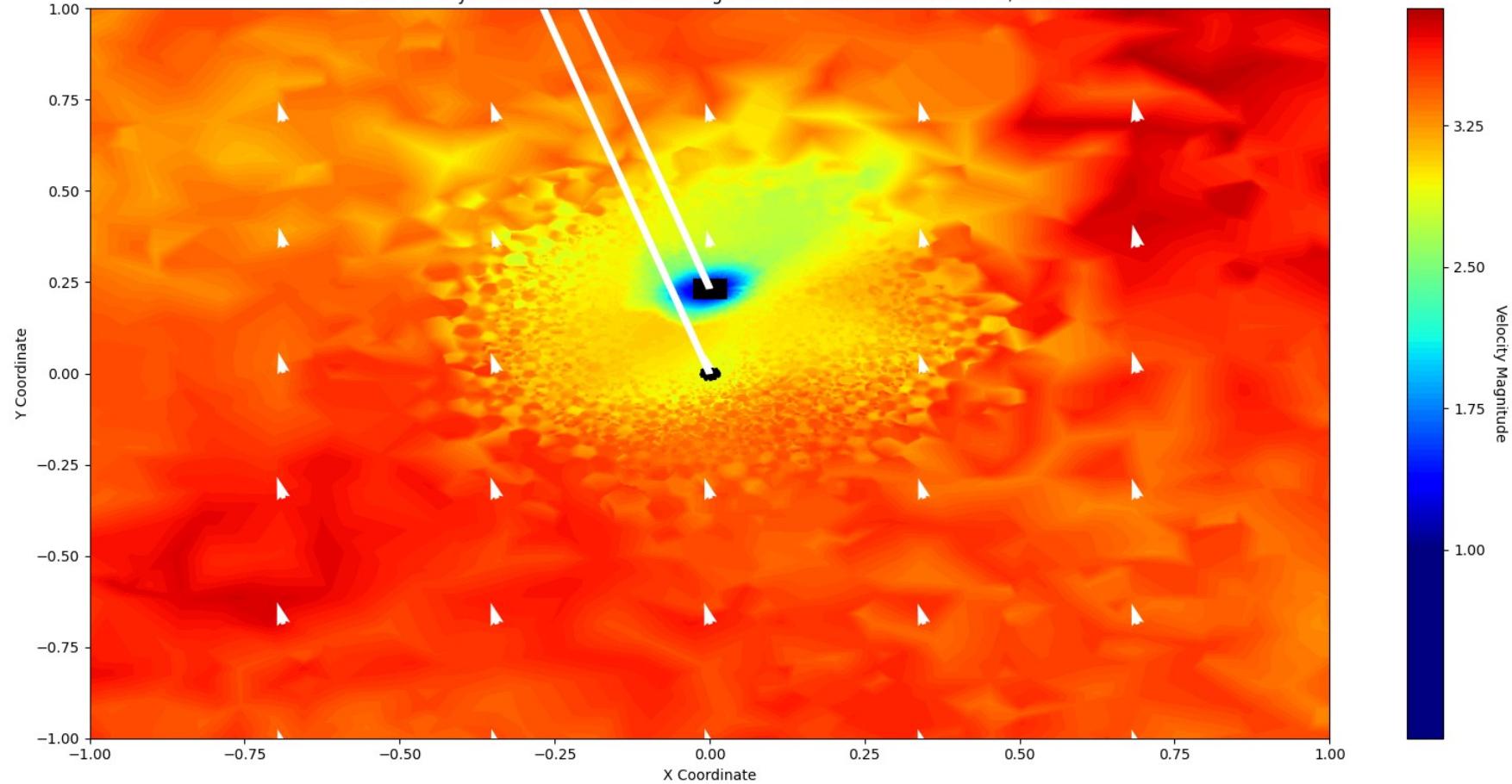
Total Velocity in the X-Y Plane for Wind Angle = 135 with a cut at Z = 0.17 +/- 0.02



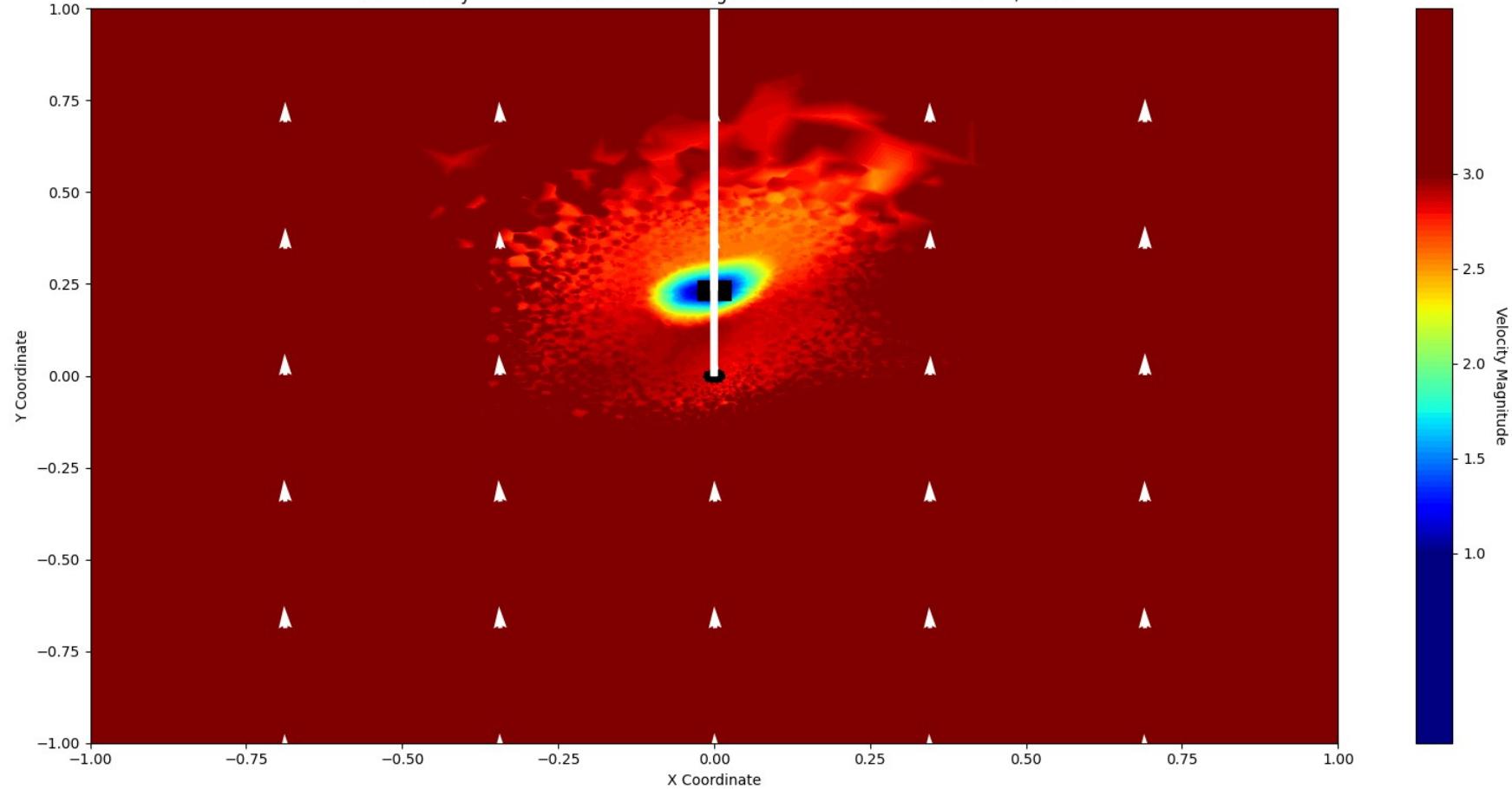
Total Velocity in the X-Y Plane for Wind Angle = 150 with a cut at Z = 0.17 +/- 0.02



Total Velocity in the X-Y Plane for Wind Angle = 165 with a cut at Z = 0.17 +/- 0.02



Total Velocity in the X-Y Plane for Wind Angle = 180 with a cut at Z = 0.17 +/- 0.02



Progress so far – Data + Cont + No Slip + Inlet Loss
Standard Normal Scalar
(Adam Optimizer)

Threshold = 1E-5 (305 Epochs, not completed), Google
Colab

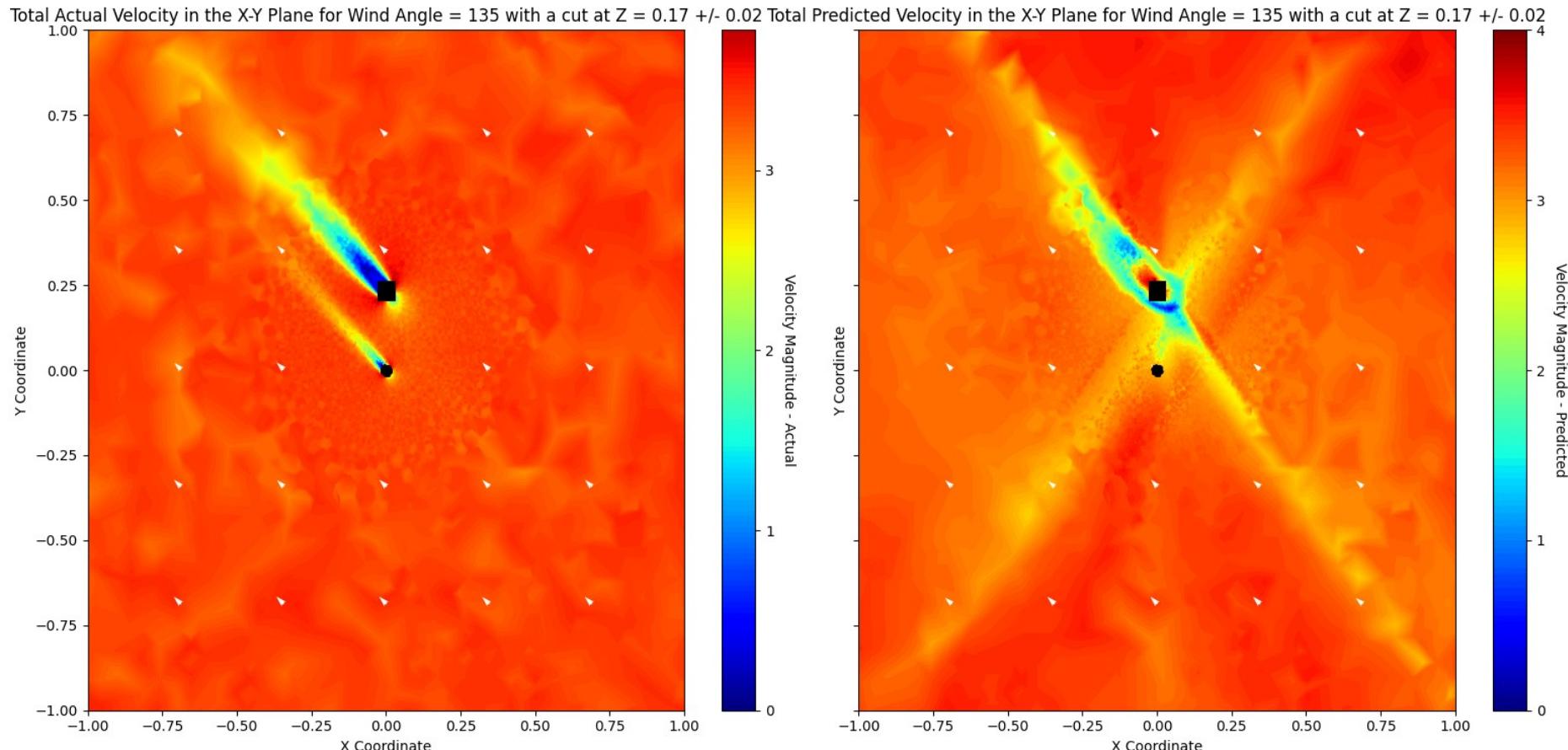
Scripts v4 – PREDICTING (135 DEG)

Progress so far - Data + Cont + No Slip + Inlet Loss (Adam Optimizer – Std Normal Scalar)
Threshold = 1E-5 (305 Epochs, so far...), Google Colab
Predicting Results – Metrics (Angle = 135)

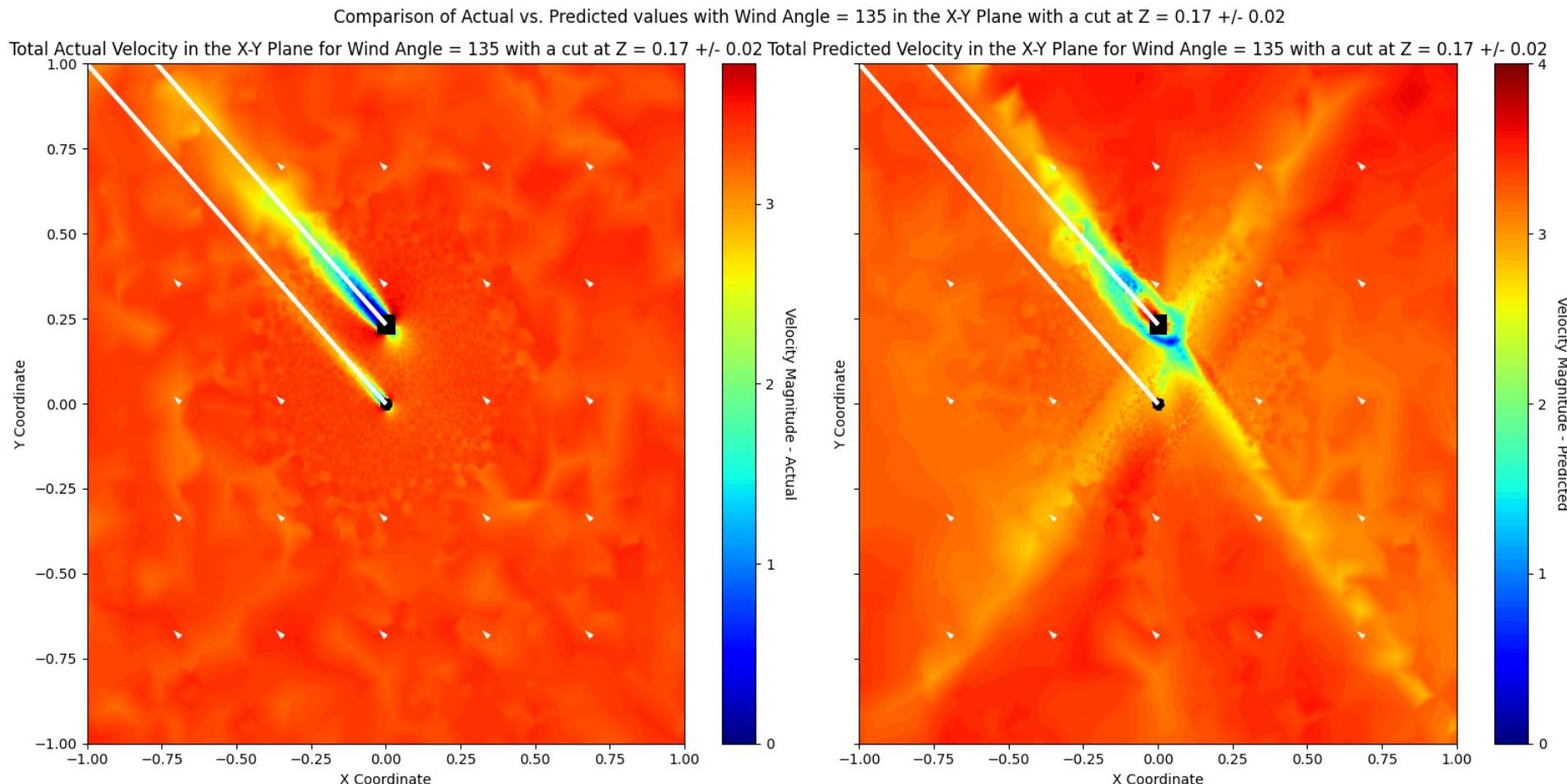
Variable	MSE	RMSE	MAE	R2
Velocity:0	0.897047555002864	0.947125944636121	0.442709809320301	0.119874805241339
Velocity:1	0.295321045145586	0.54343449020612	0.315580757770724	0.713012439942471
Velocity:2	0.0142119835311582	0.119214024054044	0.0531496399240948	0.565569558590656

Progress so far - Data + Cont + No Slip + Inlet Loss (Adam Optimizer – Std Normal Scalar), Threshold = 1E-5 (305 Epochs, so far...), Google Colab
Predicting Results - X-Y Total Velocity Plot (Angle = 135)

Comparison of Actual vs. Predicted values with Wind Angle = 135 in the X-Y Plane with a cut at Z = 0.17 +/- 0.02



Progress so far - Data + Cont + No Slip + Inlet Loss (Adam Optimizer – Std Normal Scalar), Threshold = 1E-5 (305 Epochs, so far...), Google Colab
Predicting Results - X-Y Total Velocity Plot (Angle = 135)

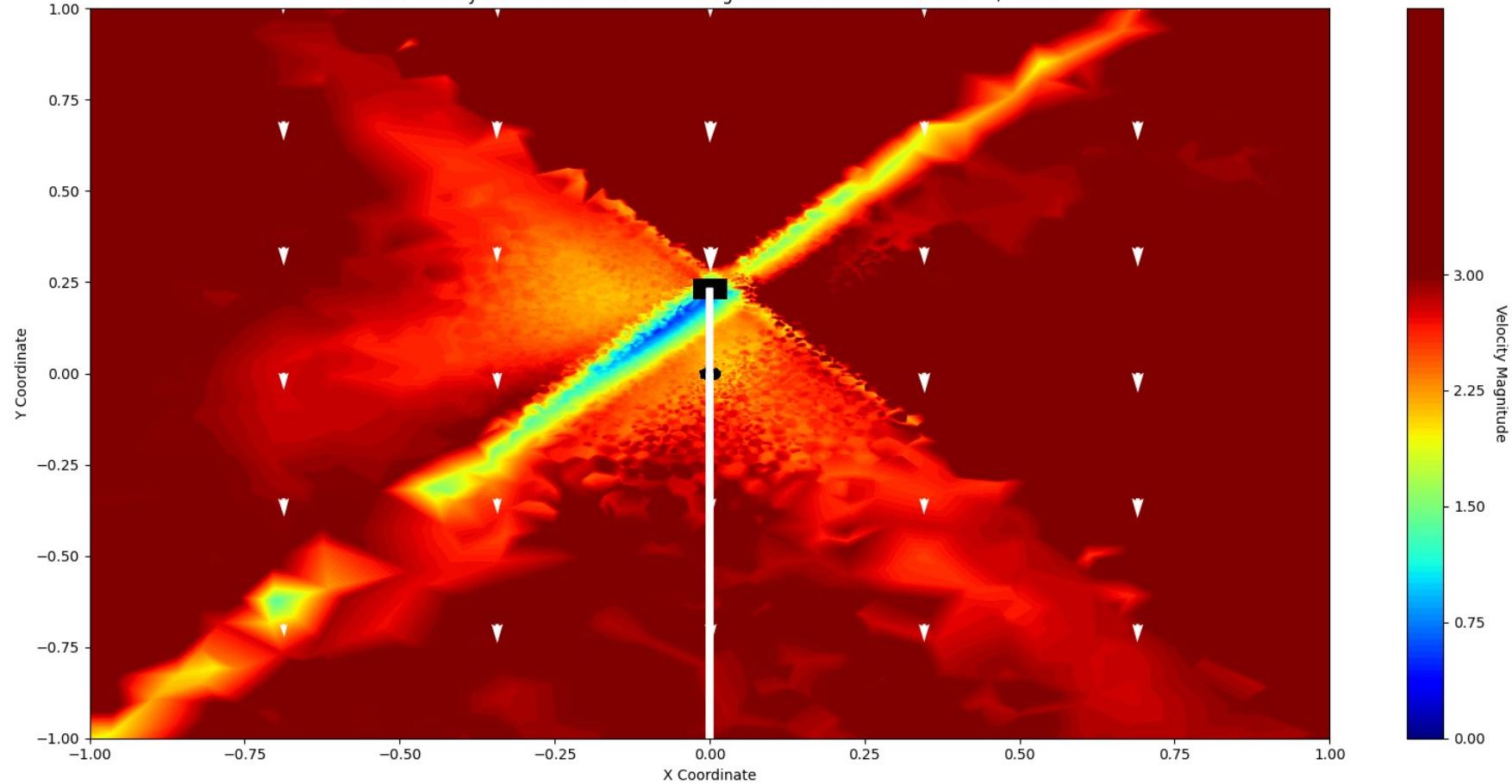


Progress so far – Data + Cont + No Slip + Inlet Loss
Standard Normal Scalar
(Adam Optimizer)

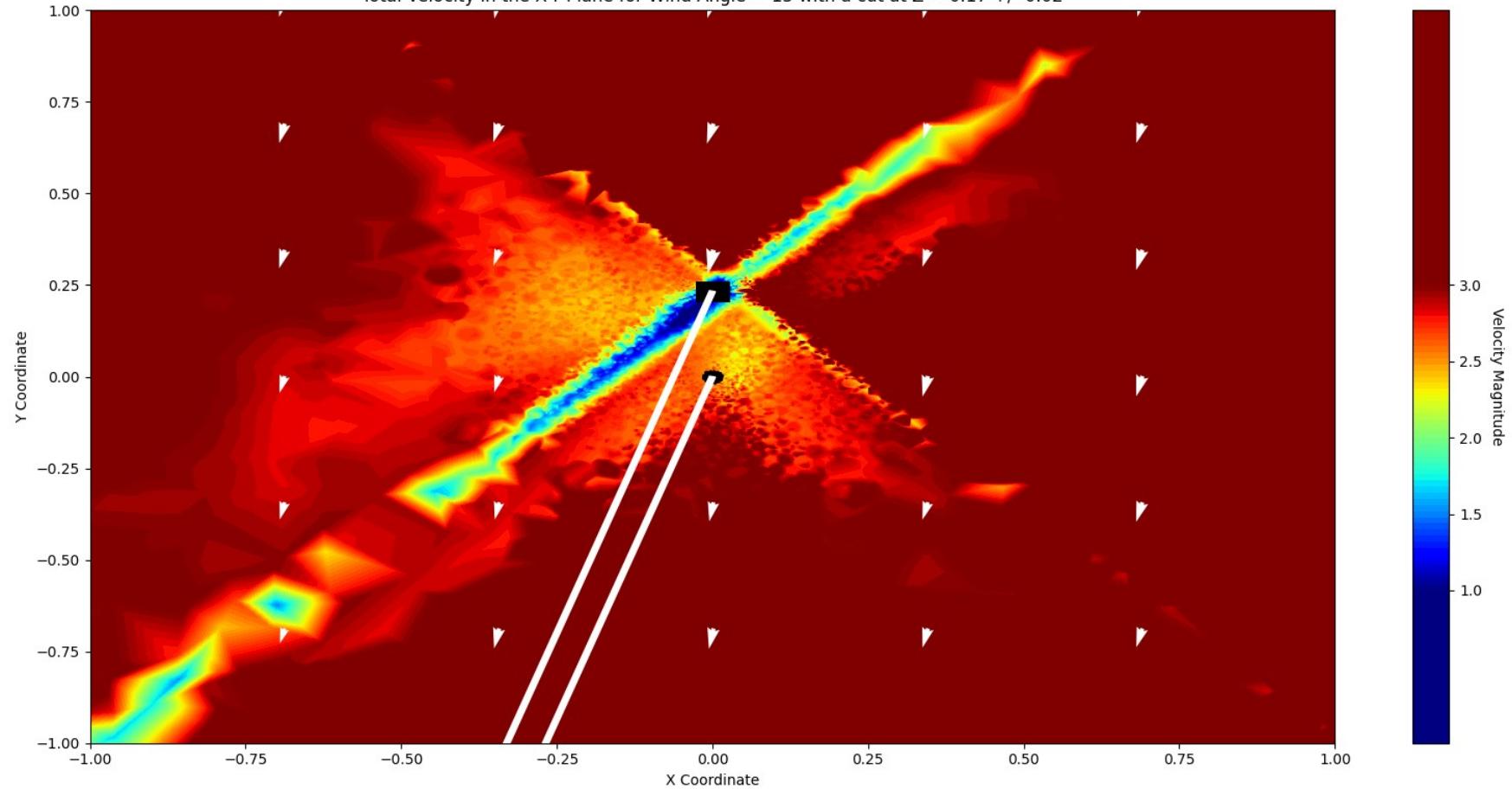
Threshold = 1E-5 (305 Epochs, not completed), Google
Colab

Scripts v4 – Plotting Any Angle

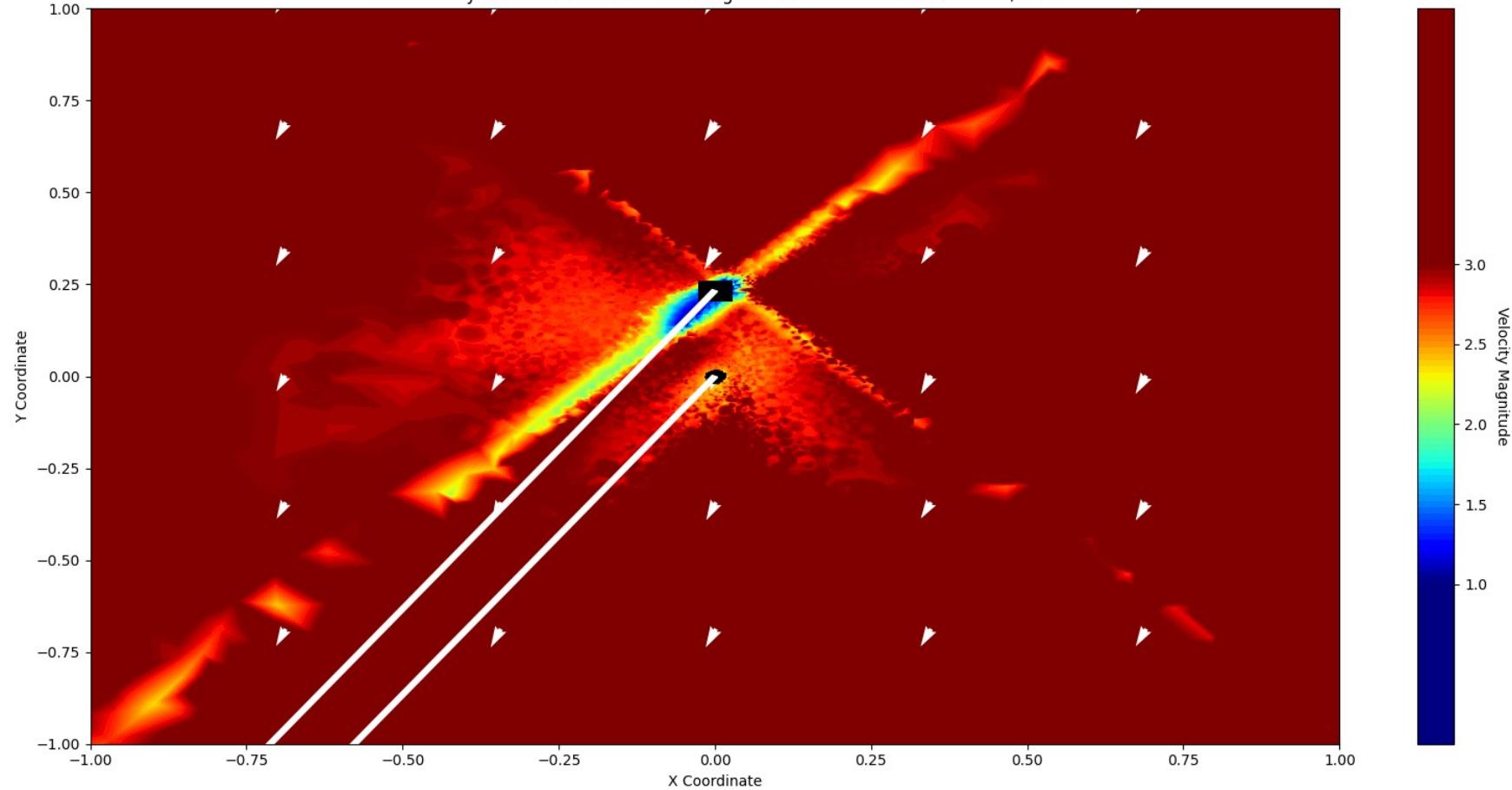
Total Velocity in the X-Y Plane for Wind Angle = 0 with a cut at Z = 0.17 +/- 0.02



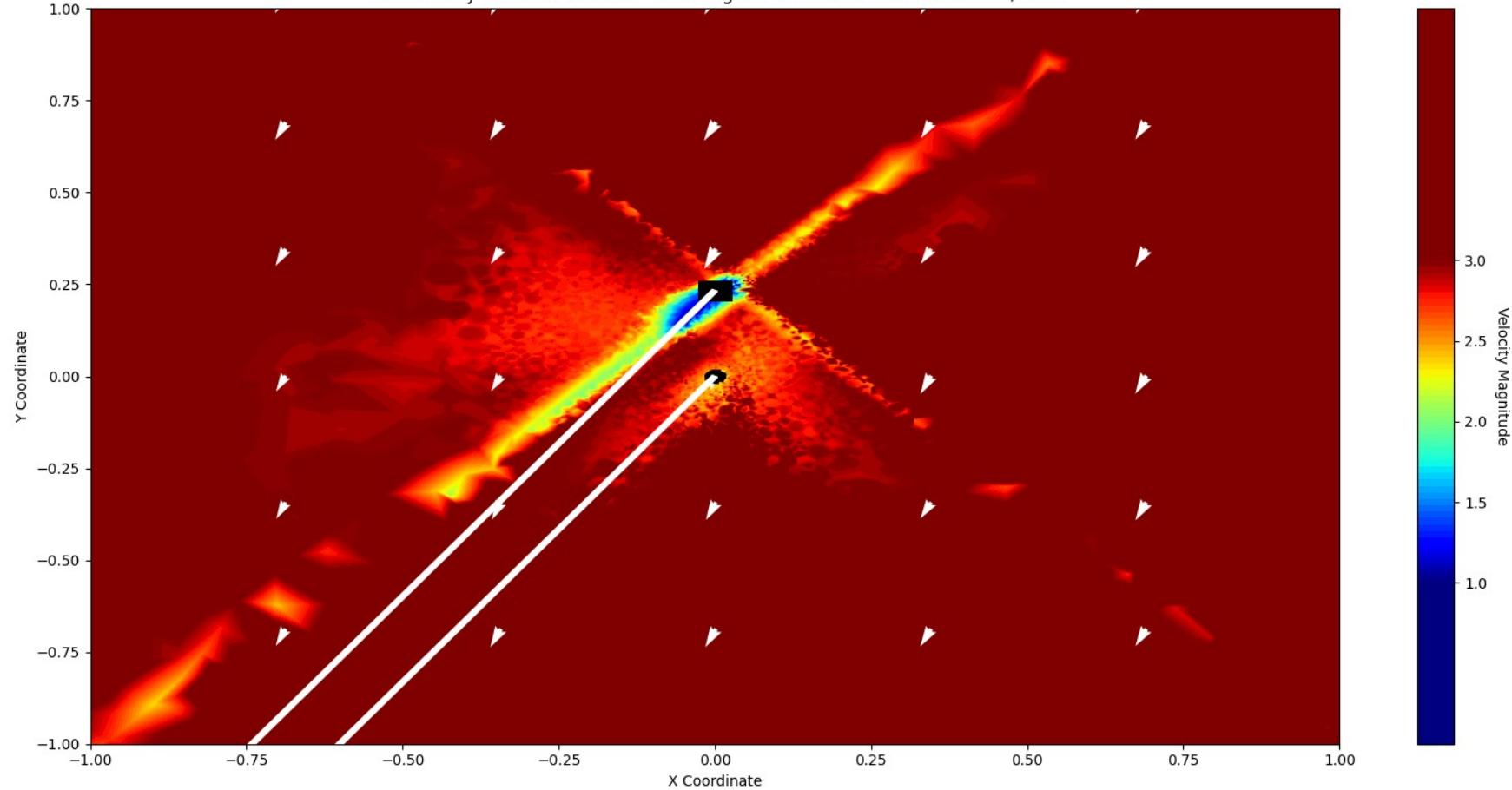
Total Velocity in the X-Y Plane for Wind Angle = 15 with a cut at Z = 0.17 +/- 0.02



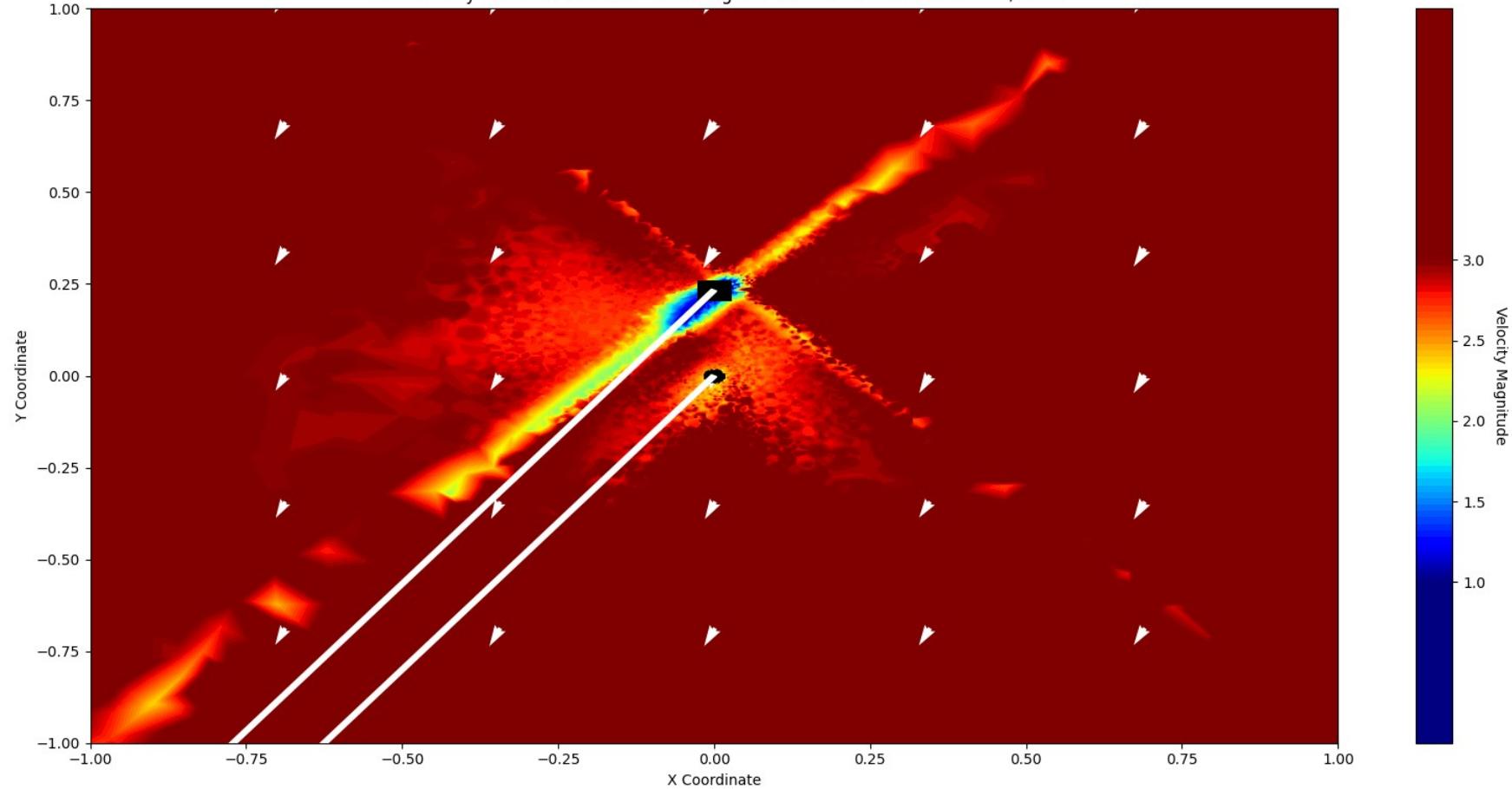
Total Velocity in the X-Y Plane for Wind Angle = 30 with a cut at Z = 0.17 +/- 0.02



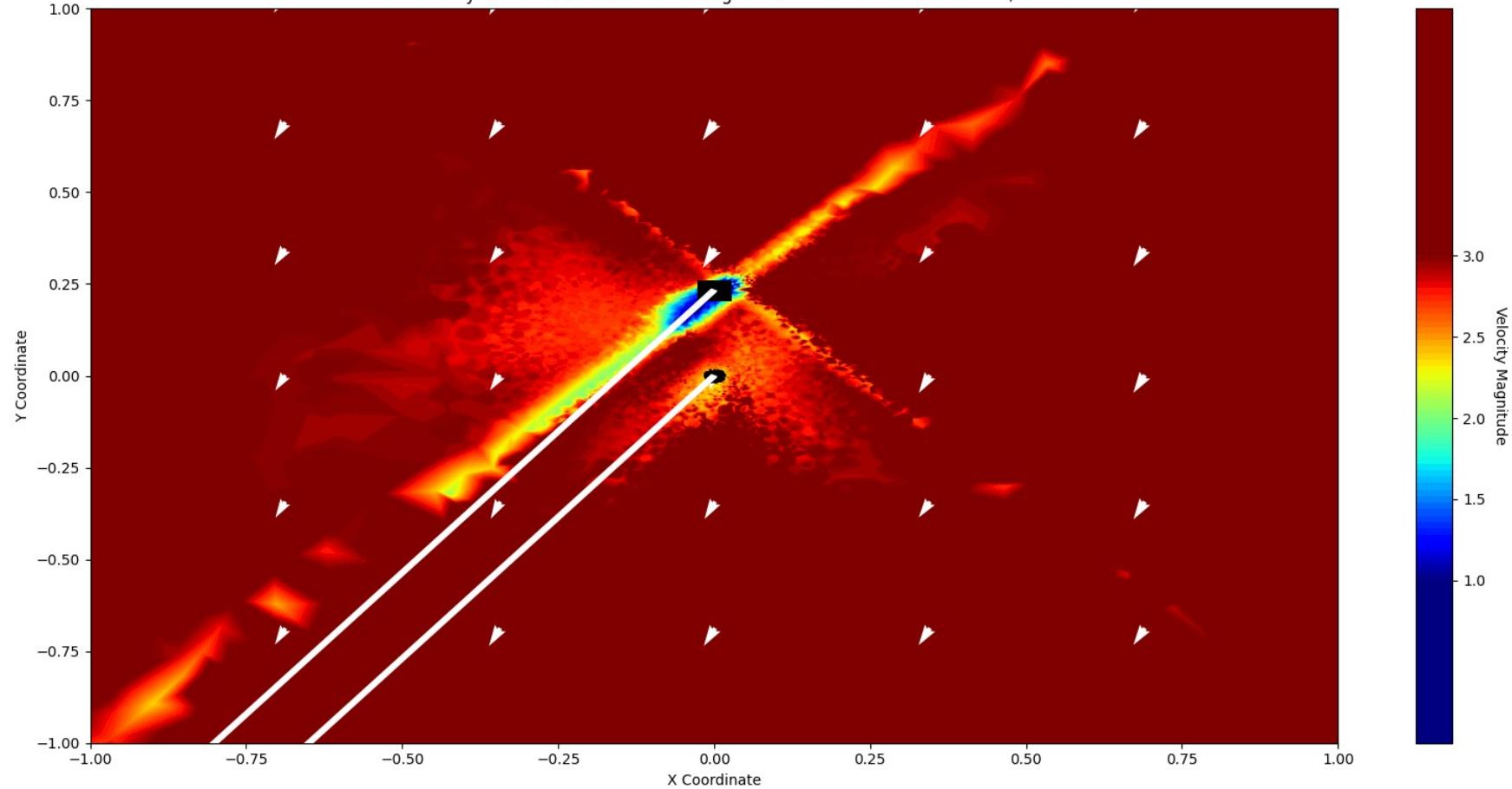
Total Velocity in the X-Y Plane for Wind Angle = 31 with a cut at Z = 0.17 +/- 0.02



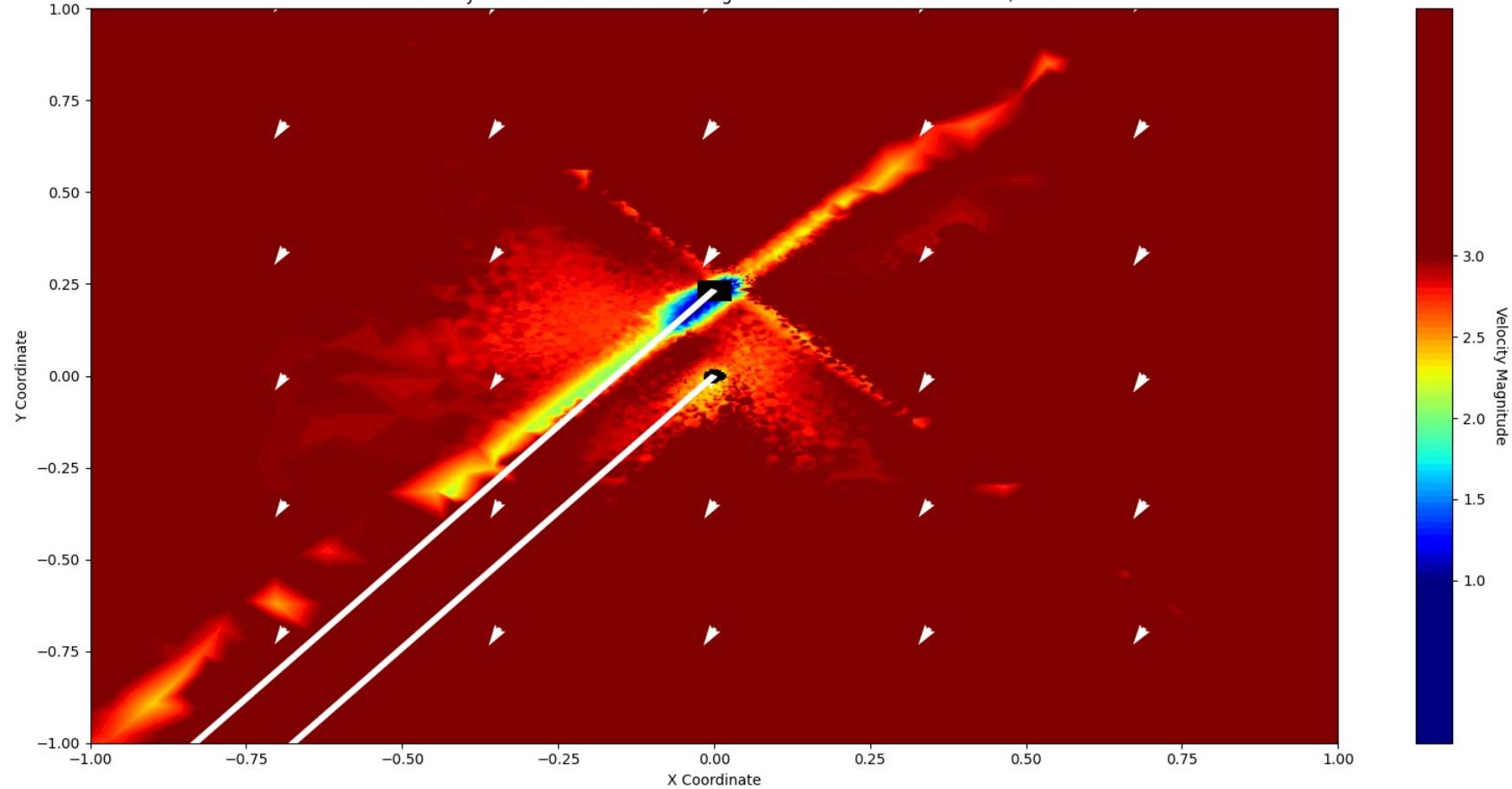
Total Velocity in the X-Y Plane for Wind Angle = 32 with a cut at Z = 0.17 +/- 0.02



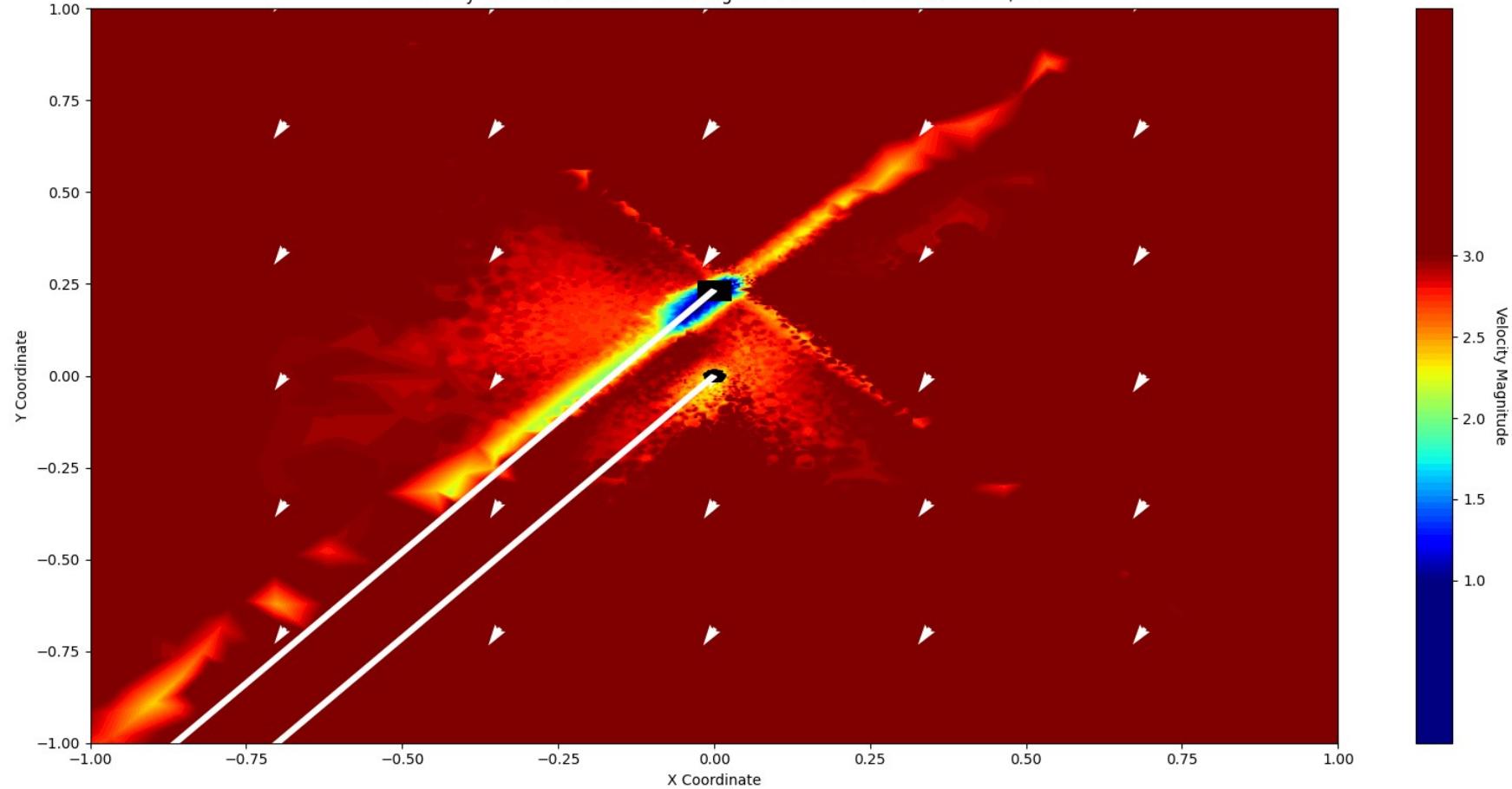
Total Velocity in the X-Y Plane for Wind Angle = 33 with a cut at Z = 0.17 +/- 0.02



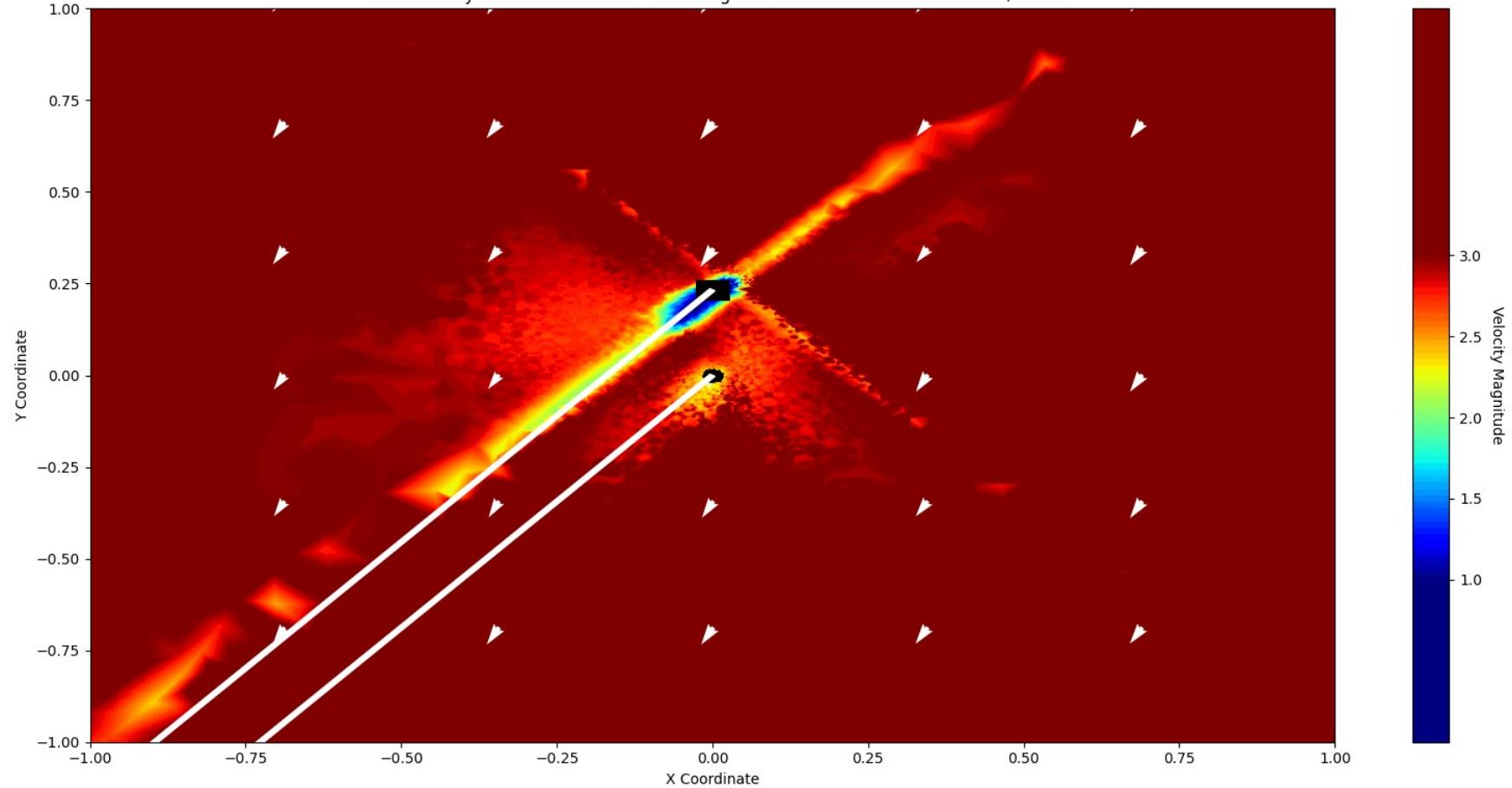
Total Velocity in the X-Y Plane for Wind Angle = 34 with a cut at Z = 0.17 +/- 0.02



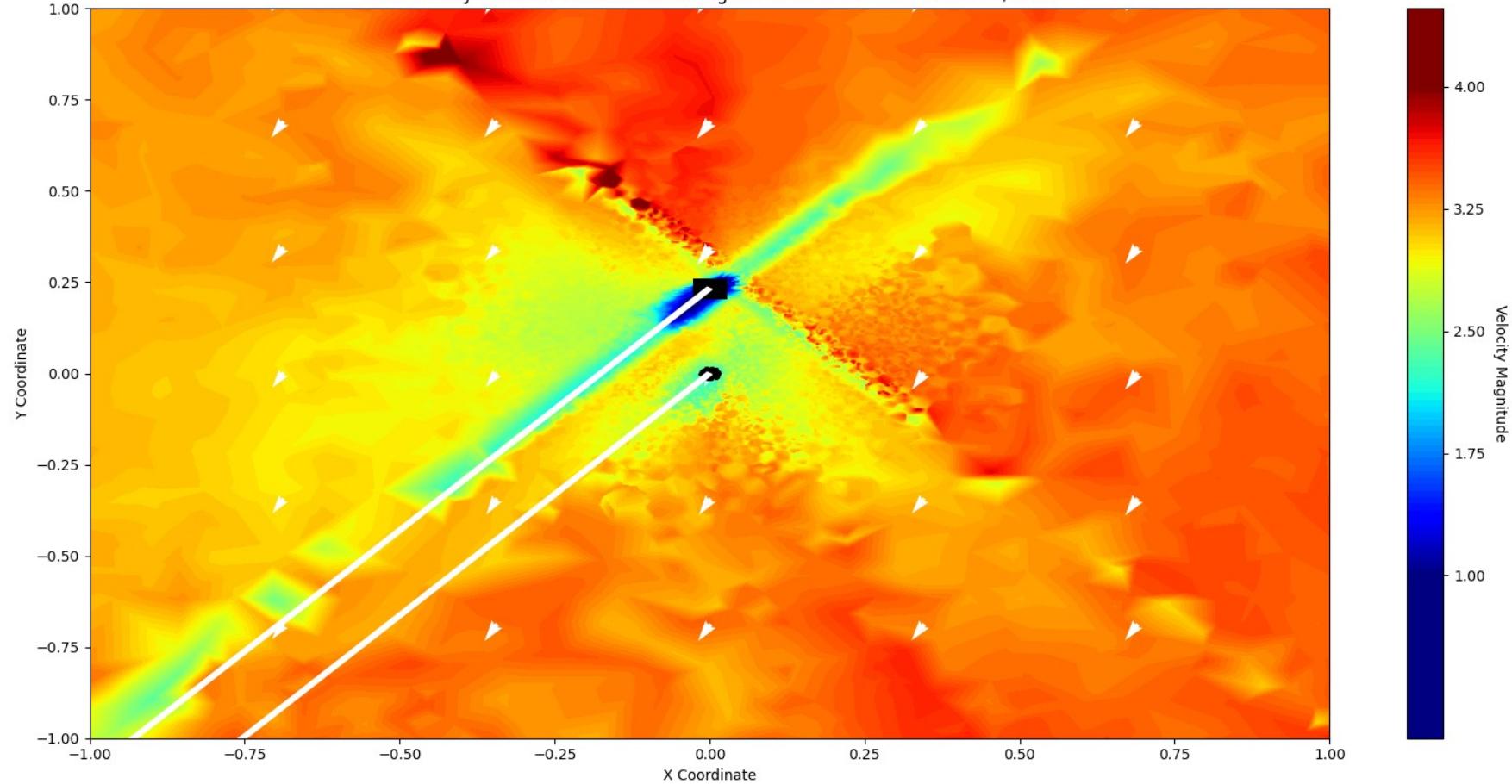
Total Velocity in the X-Y Plane for Wind Angle = 35 with a cut at Z = 0.17 +/- 0.02



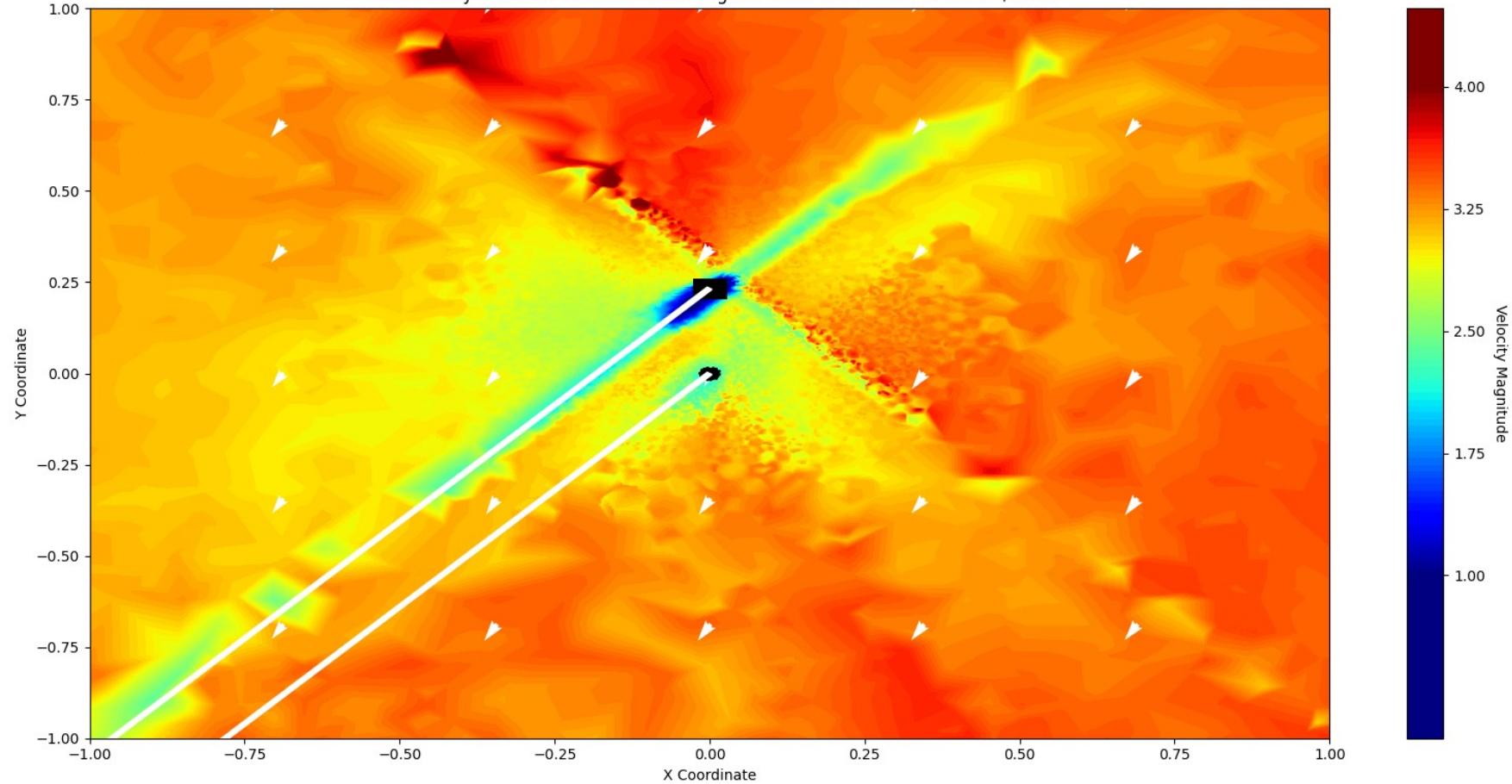
Total Velocity in the X-Y Plane for Wind Angle = 36 with a cut at Z = 0.17 +/- 0.02



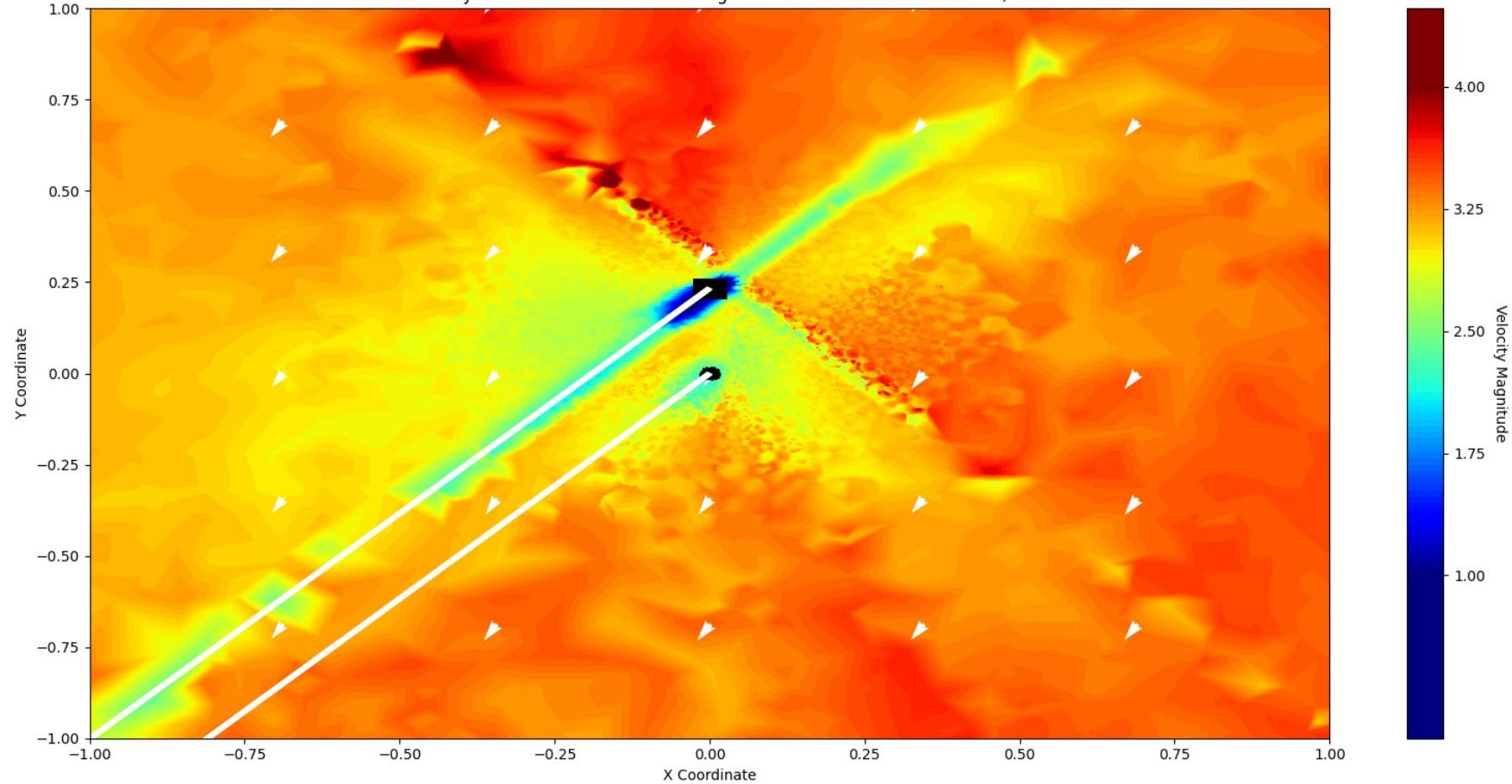
Total Velocity in the X-Y Plane for Wind Angle = 37 with a cut at Z = 0.17 +/- 0.02



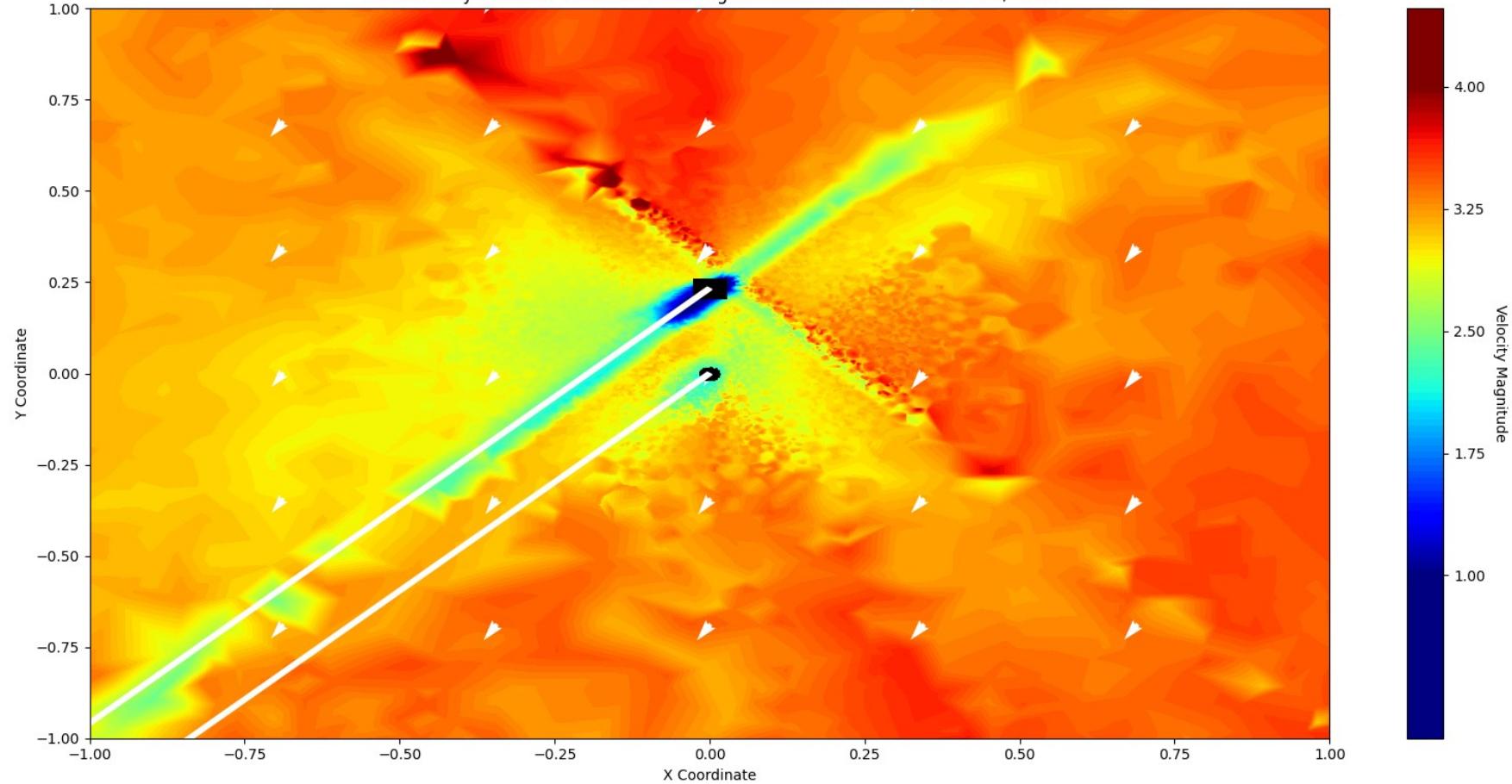
Total Velocity in the X-Y Plane for Wind Angle = 38 with a cut at Z = 0.17 +/- 0.02



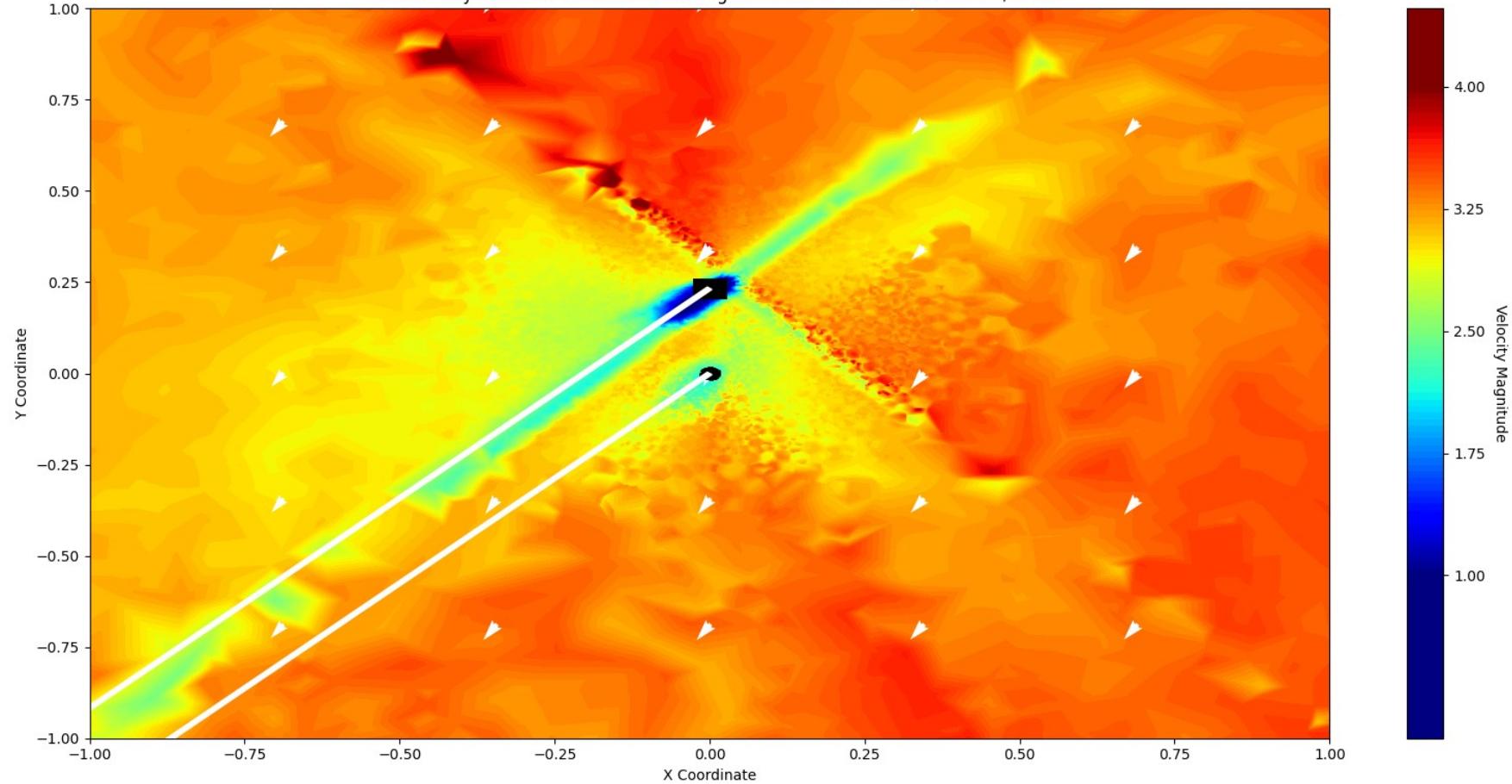
Total Velocity in the X-Y Plane for Wind Angle = 39 with a cut at Z = 0.17 +/- 0.02



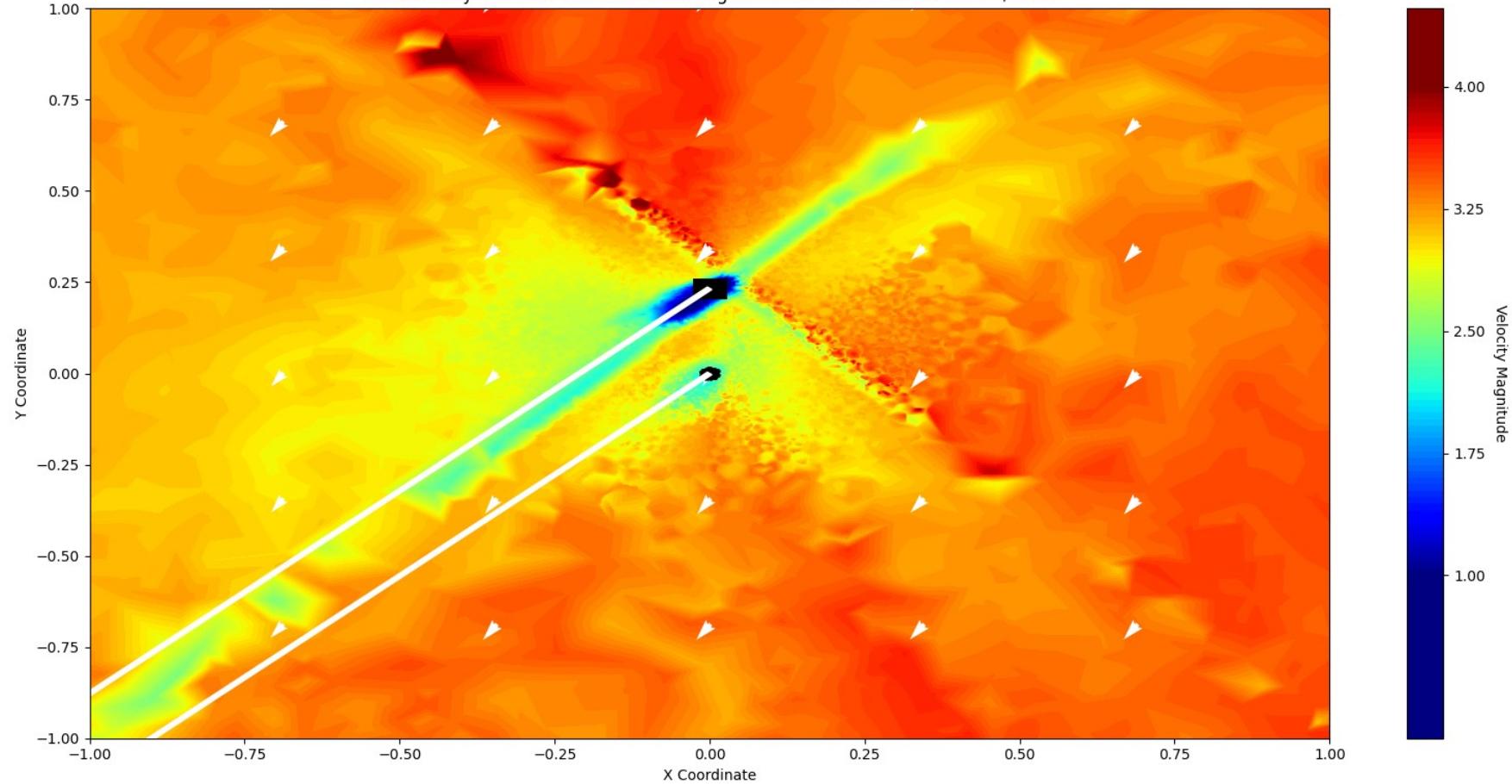
Total Velocity in the X-Y Plane for Wind Angle = 40 with a cut at Z = 0.17 +/- 0.02



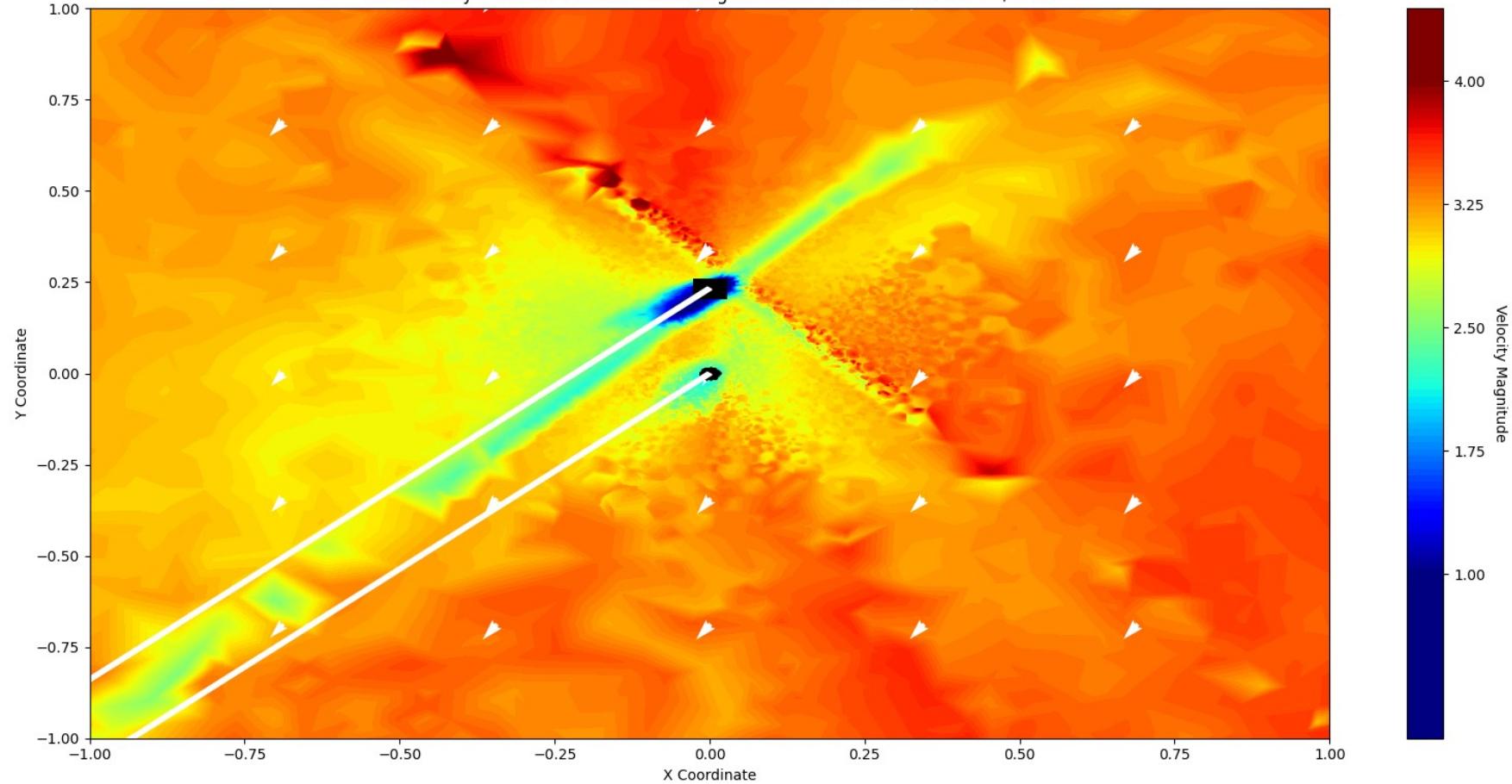
Total Velocity in the X-Y Plane for Wind Angle = 41 with a cut at Z = 0.17 +/- 0.02



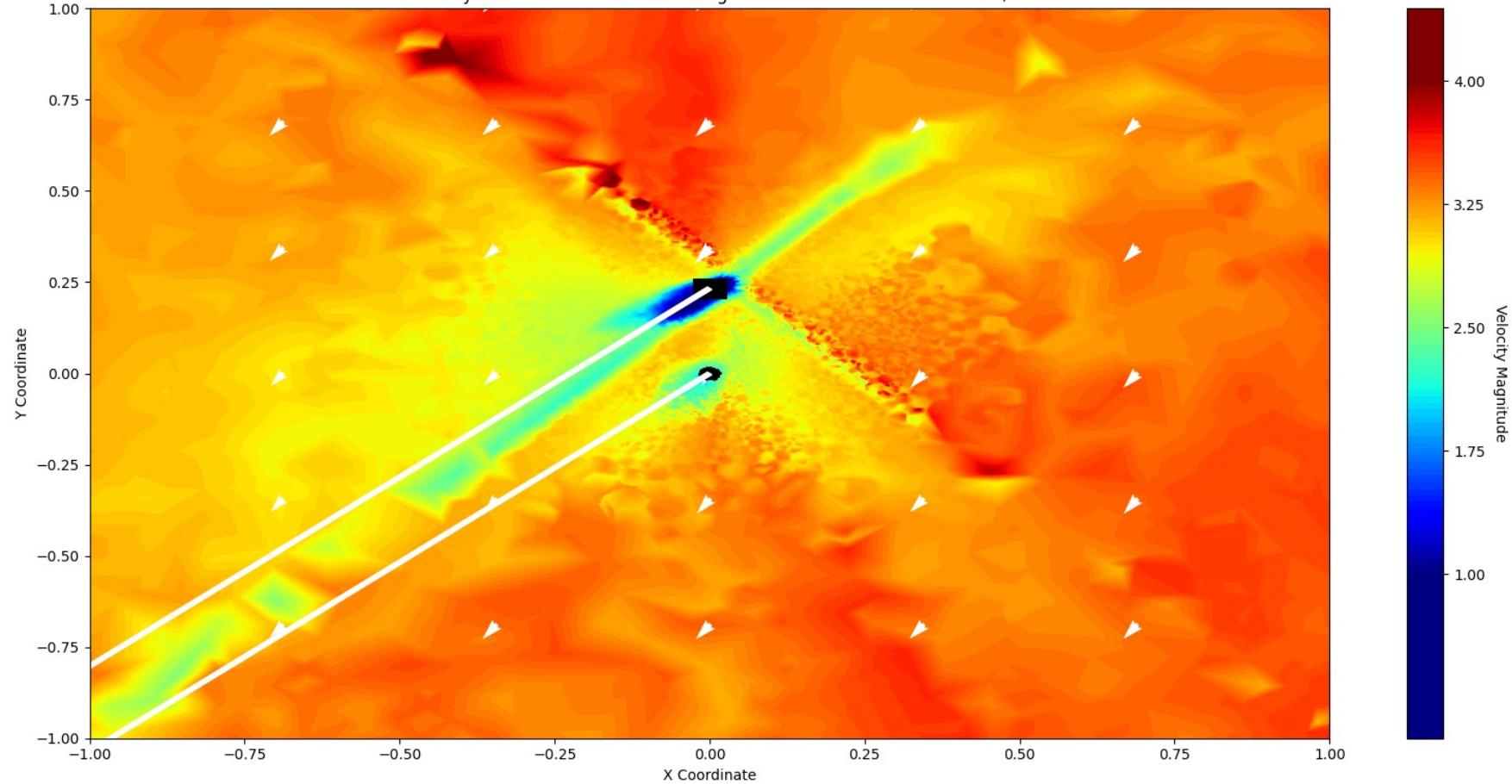
Total Velocity in the X-Y Plane for Wind Angle = 42 with a cut at Z = 0.17 +/- 0.02



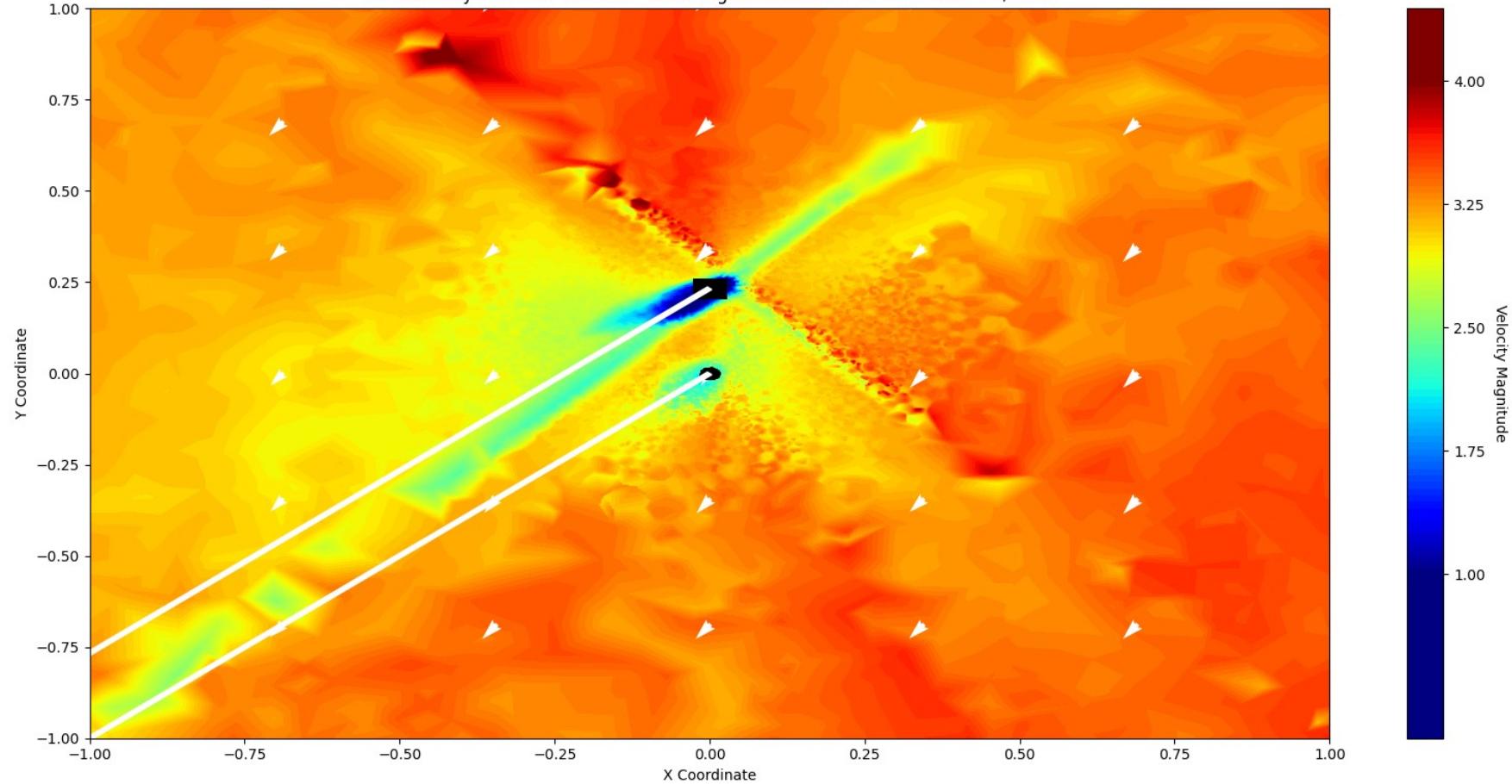
Total Velocity in the X-Y Plane for Wind Angle = 43 with a cut at Z = 0.17 +/- 0.02



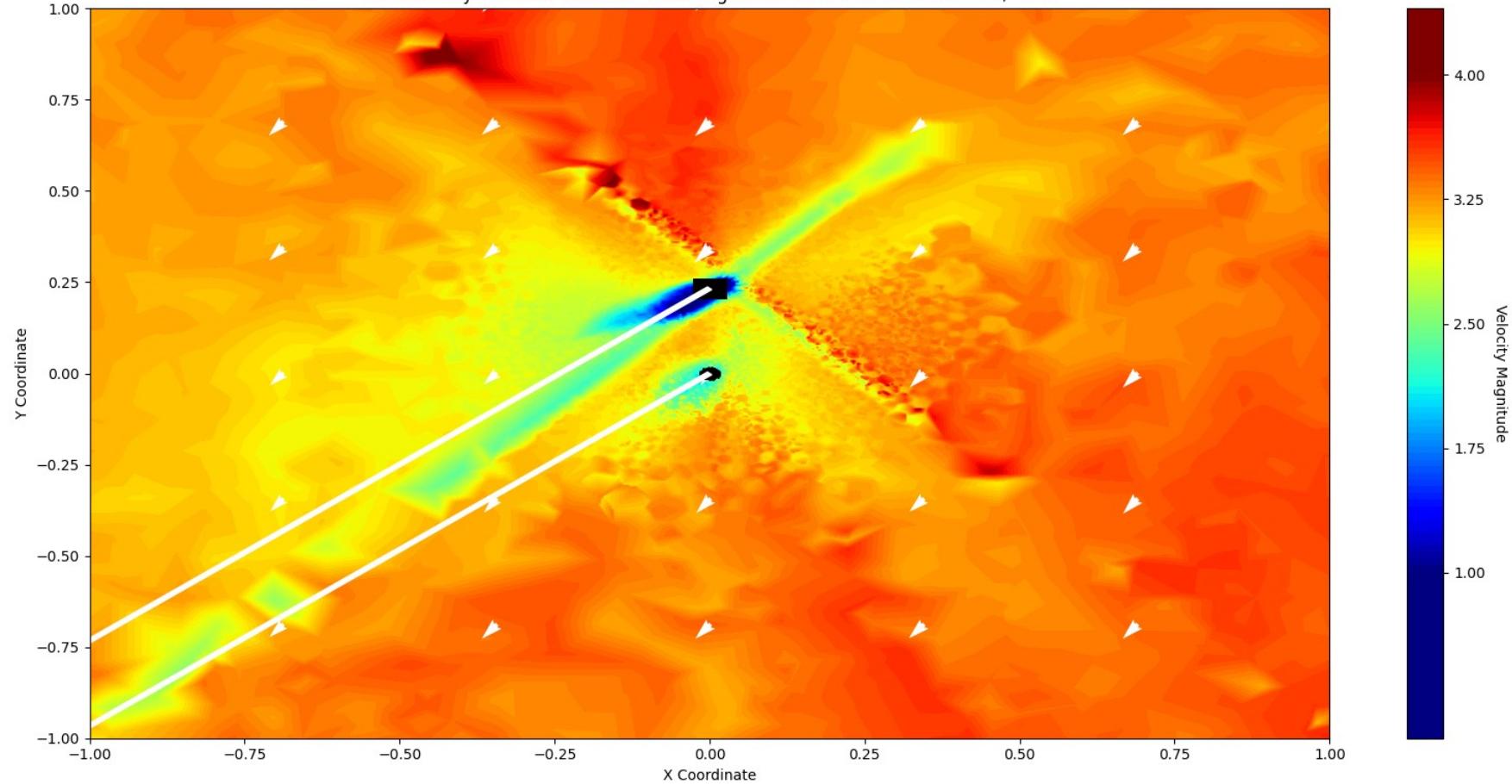
Total Velocity in the X-Y Plane for Wind Angle = 44 with a cut at Z = 0.17 +/- 0.02



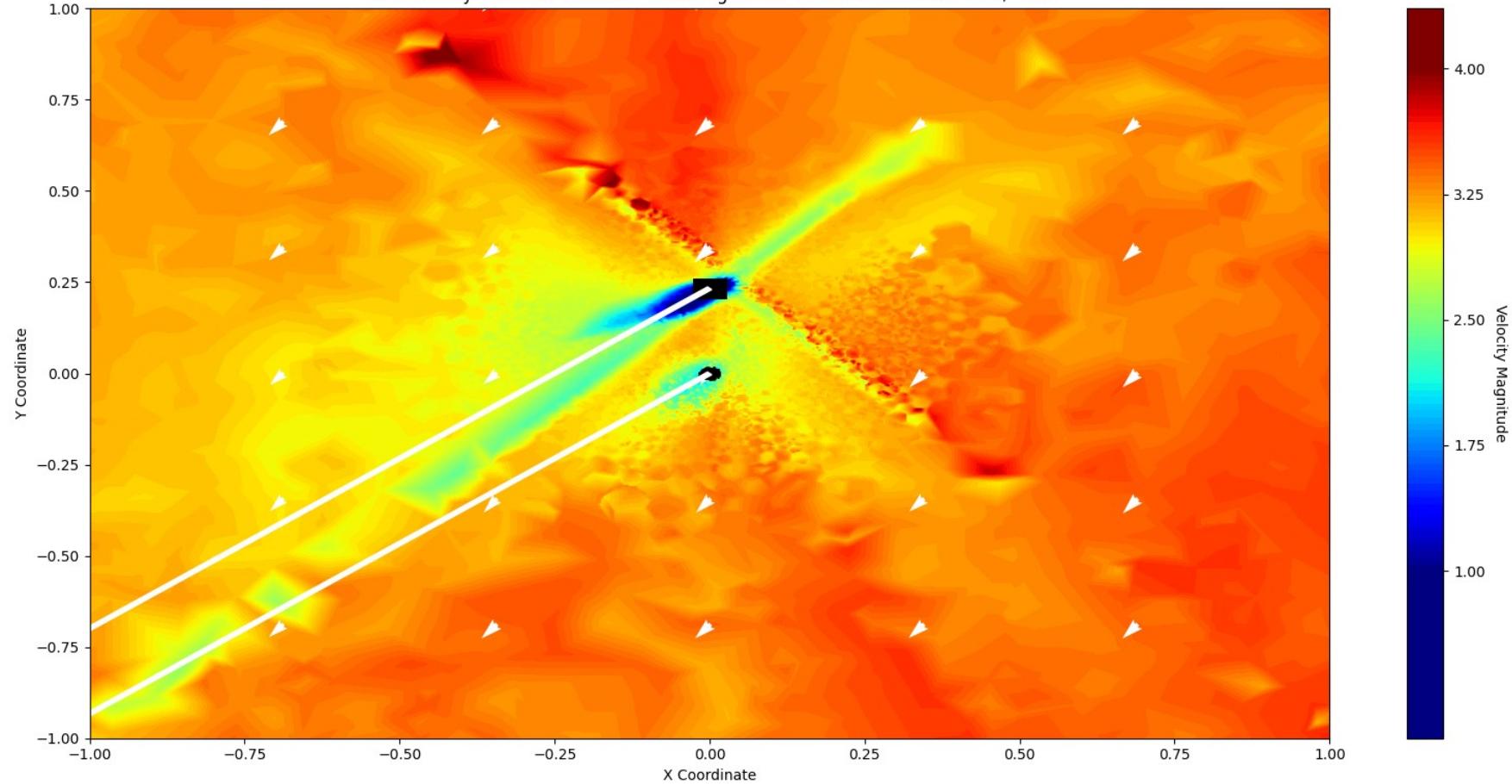
Total Velocity in the X-Y Plane for Wind Angle = 45 with a cut at Z = 0.17 +/- 0.02



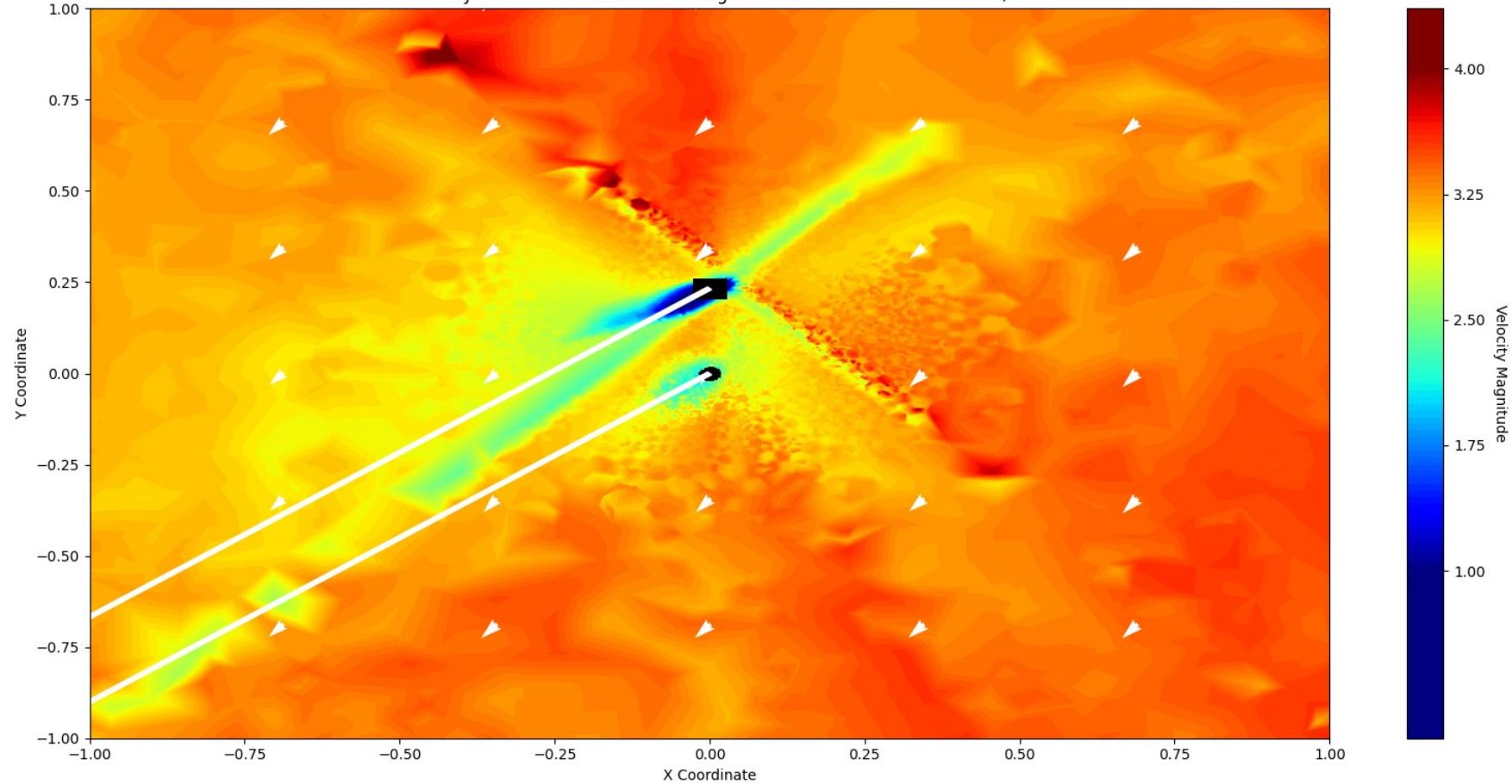
Total Velocity in the X-Y Plane for Wind Angle = 46 with a cut at Z = 0.17 +/- 0.02



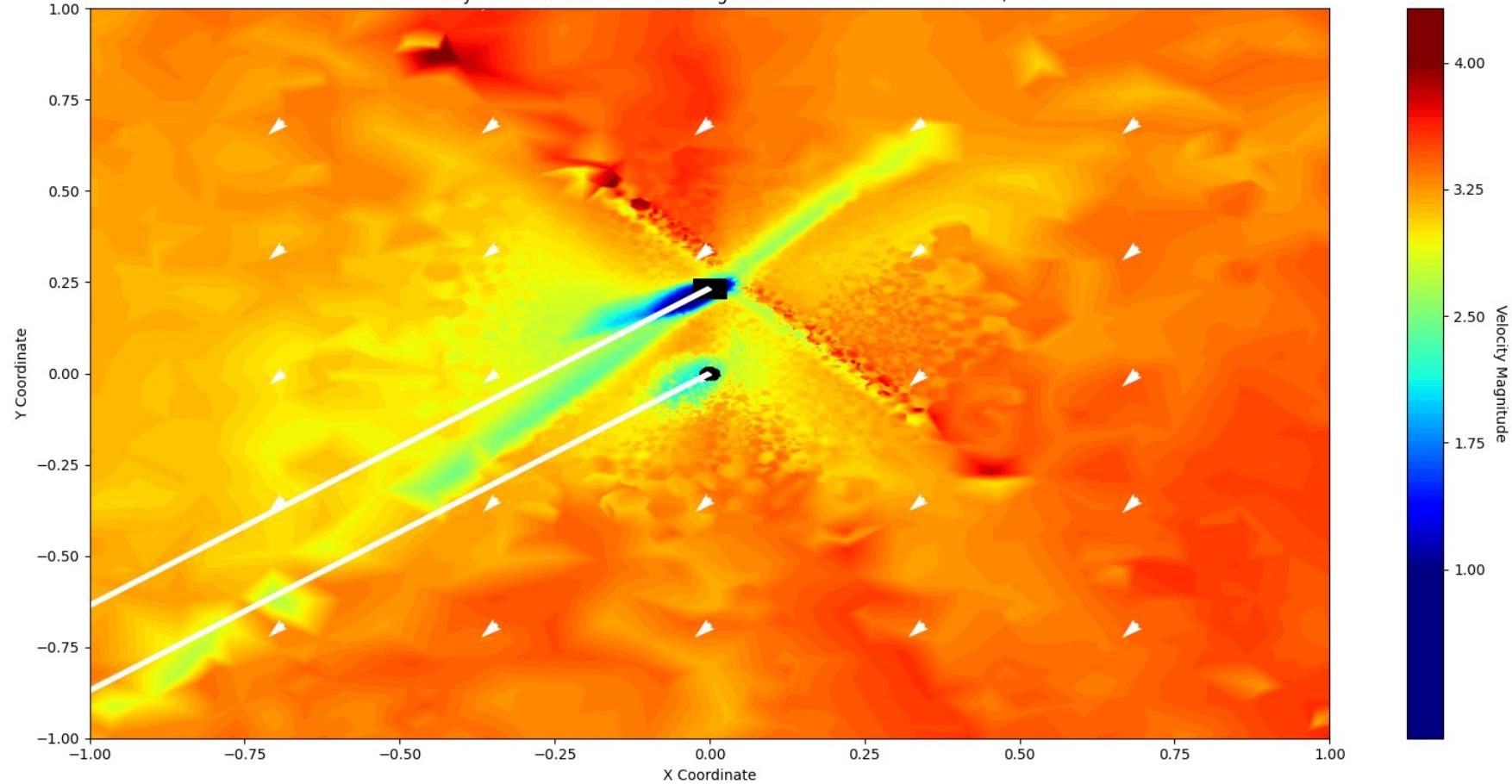
Total Velocity in the X-Y Plane for Wind Angle = 47 with a cut at Z = 0.17 +/- 0.02



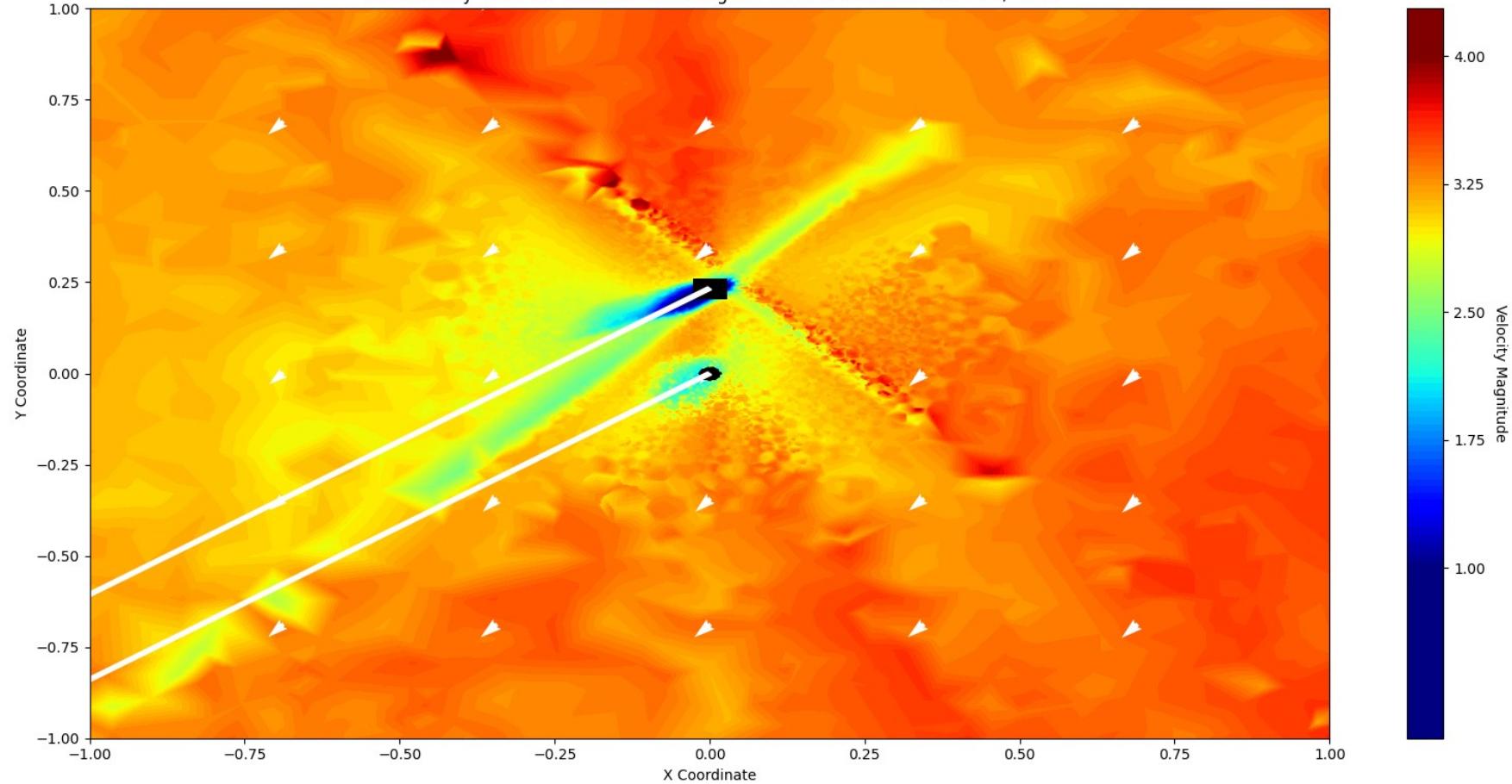
Total Velocity in the X-Y Plane for Wind Angle = 48 with a cut at Z = 0.17 +/- 0.02



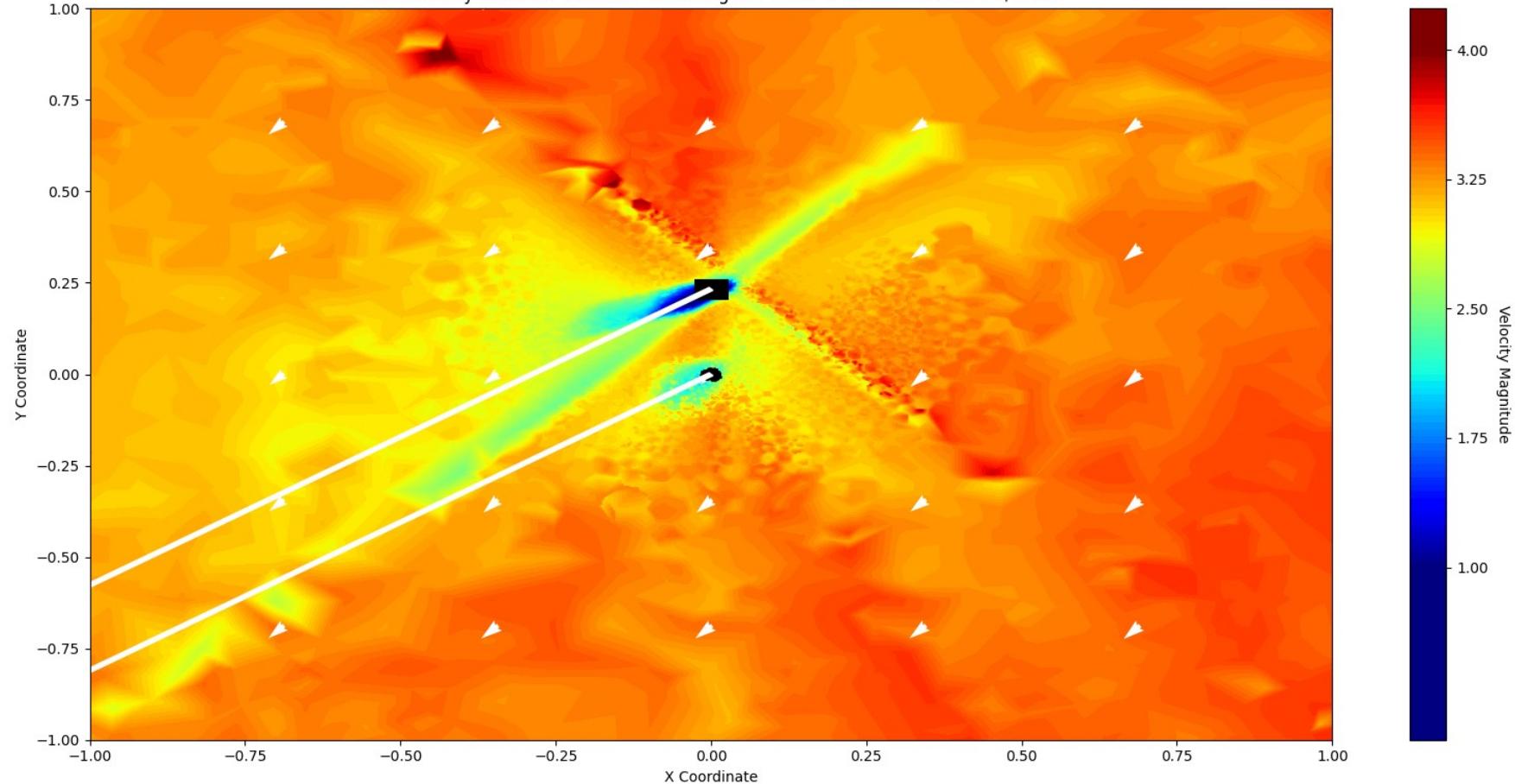
Total Velocity in the X-Y Plane for Wind Angle = 49 with a cut at Z = 0.17 +/- 0.02



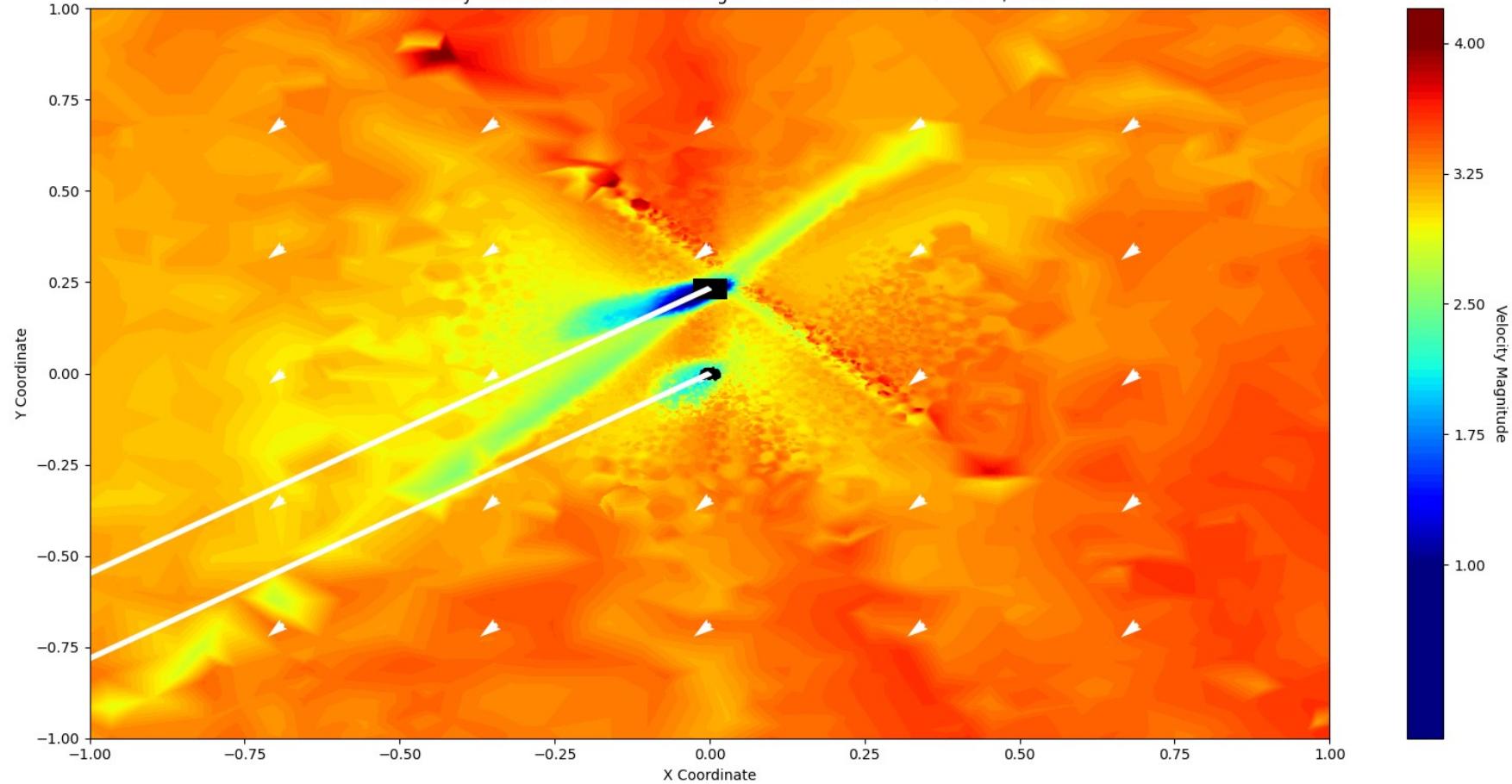
Total Velocity in the X-Y Plane for Wind Angle = 50 with a cut at Z = 0.17 +/- 0.02



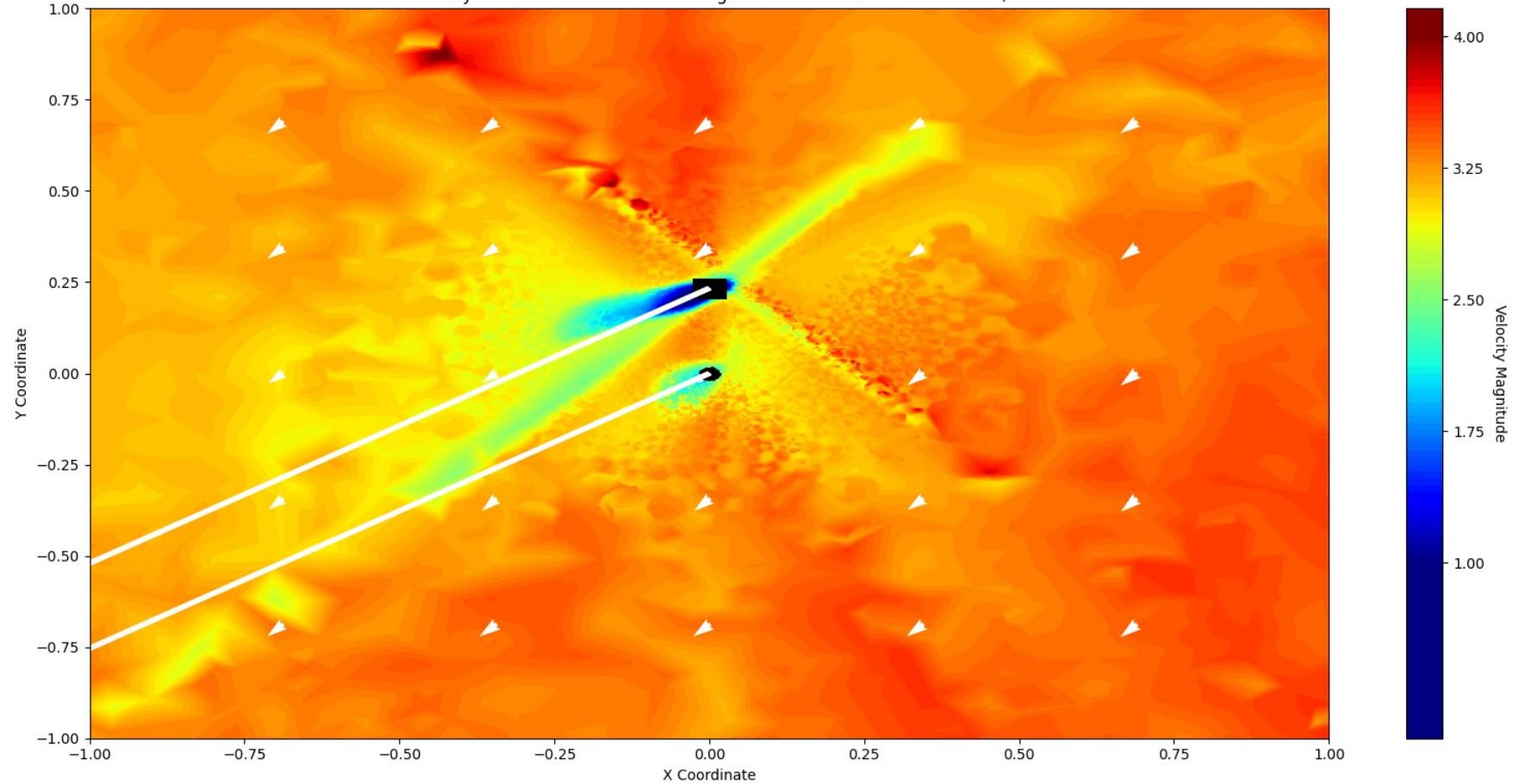
Total Velocity in the X-Y Plane for Wind Angle = 51 with a cut at Z = 0.17 +/- 0.02



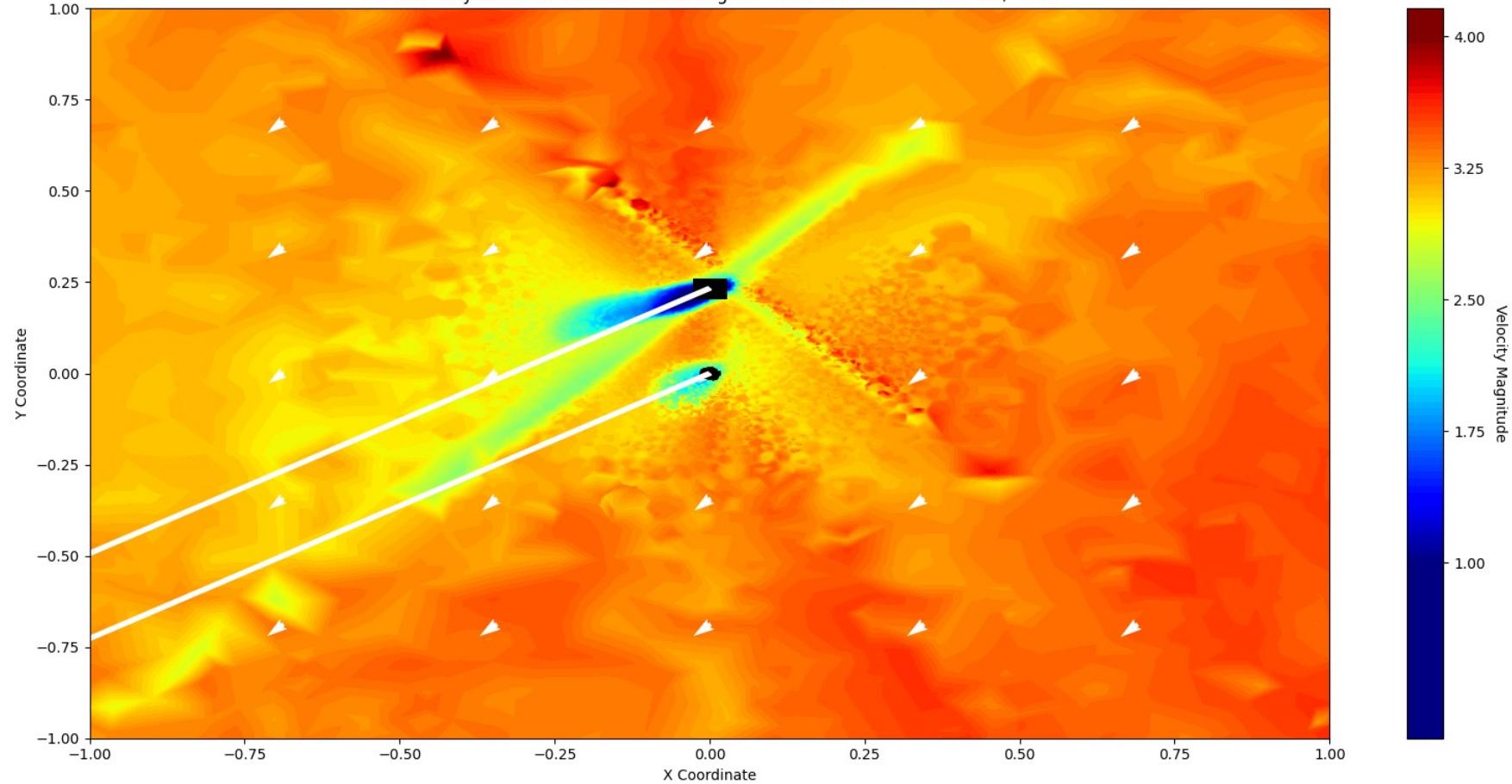
Total Velocity in the X-Y Plane for Wind Angle = 52 with a cut at Z = 0.17 +/- 0.02



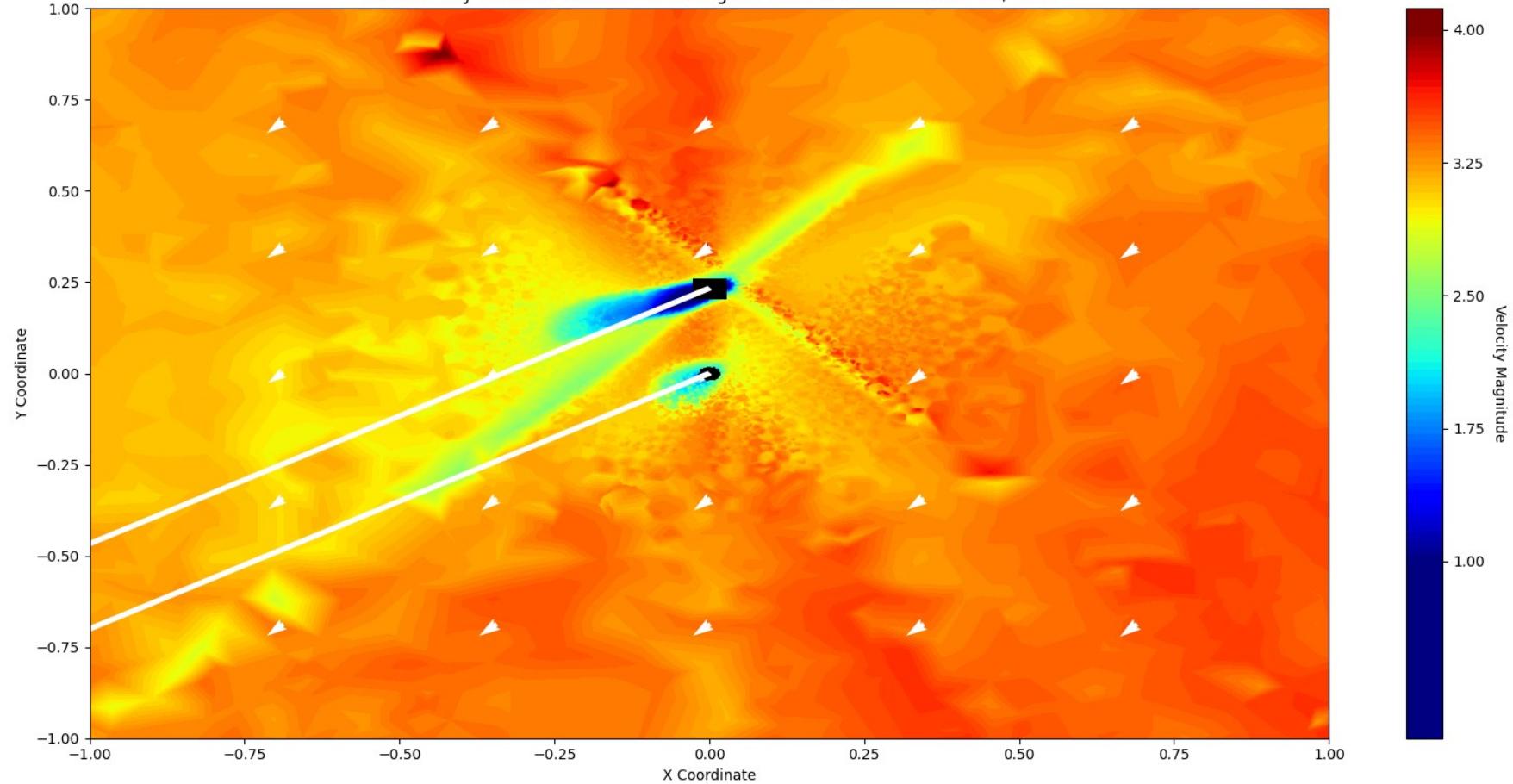
Total Velocity in the X-Y Plane for Wind Angle = 53 with a cut at Z = 0.17 +/- 0.02



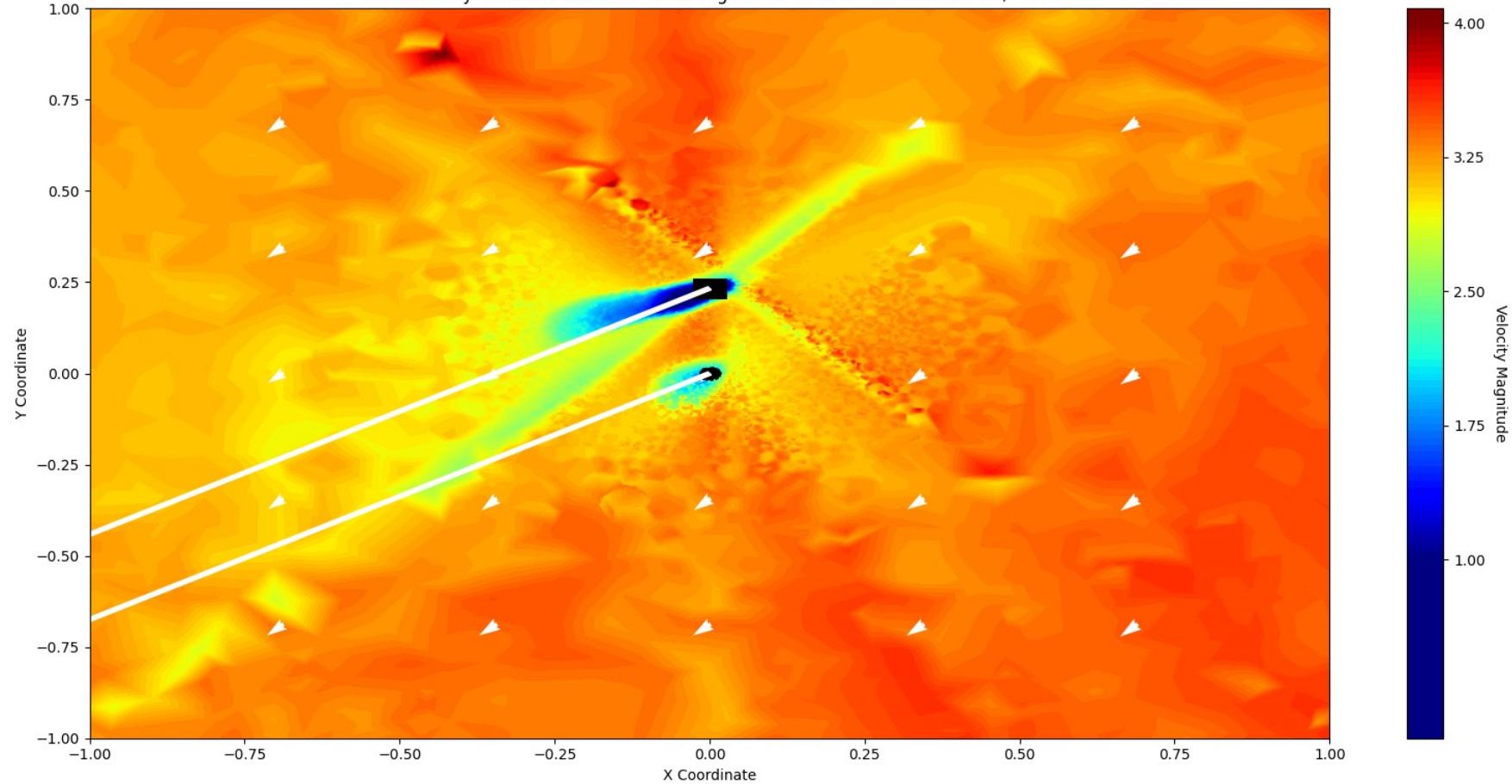
Total Velocity in the X-Y Plane for Wind Angle = 54 with a cut at Z = 0.17 +/- 0.02



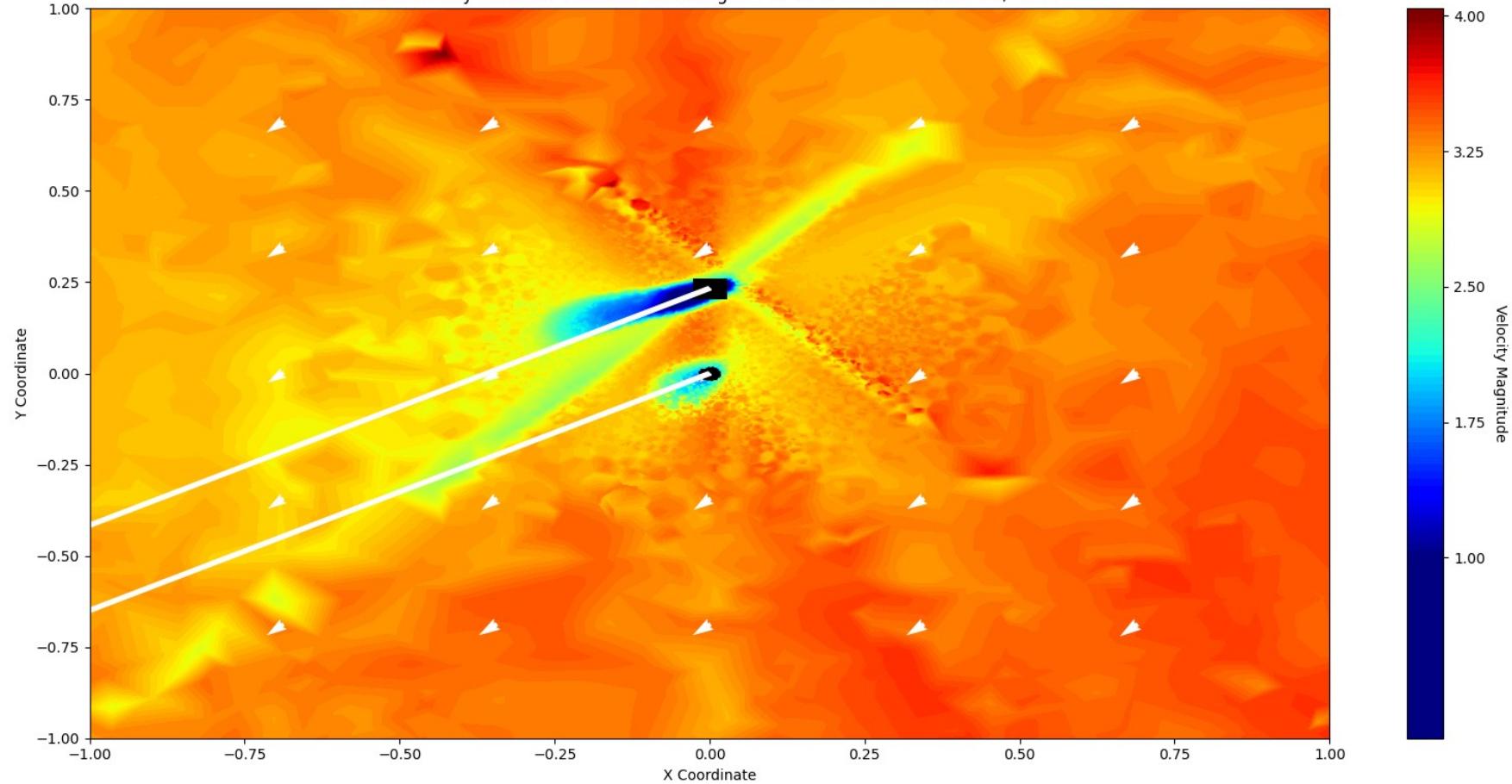
Total Velocity in the X-Y Plane for Wind Angle = 55 with a cut at Z = 0.17 +/- 0.02



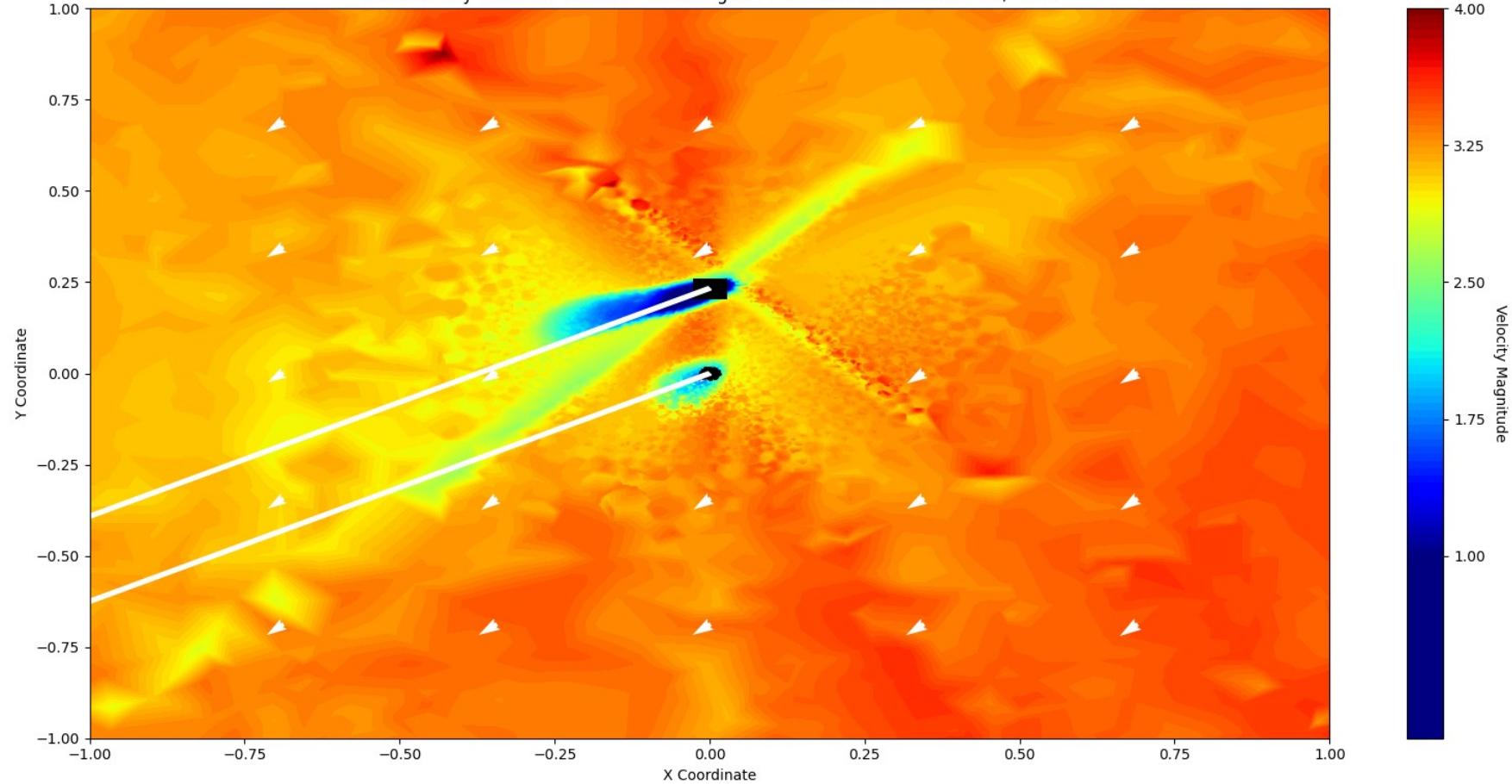
Total Velocity in the X-Y Plane for Wind Angle = 56 with a cut at Z = 0.17 +/- 0.02



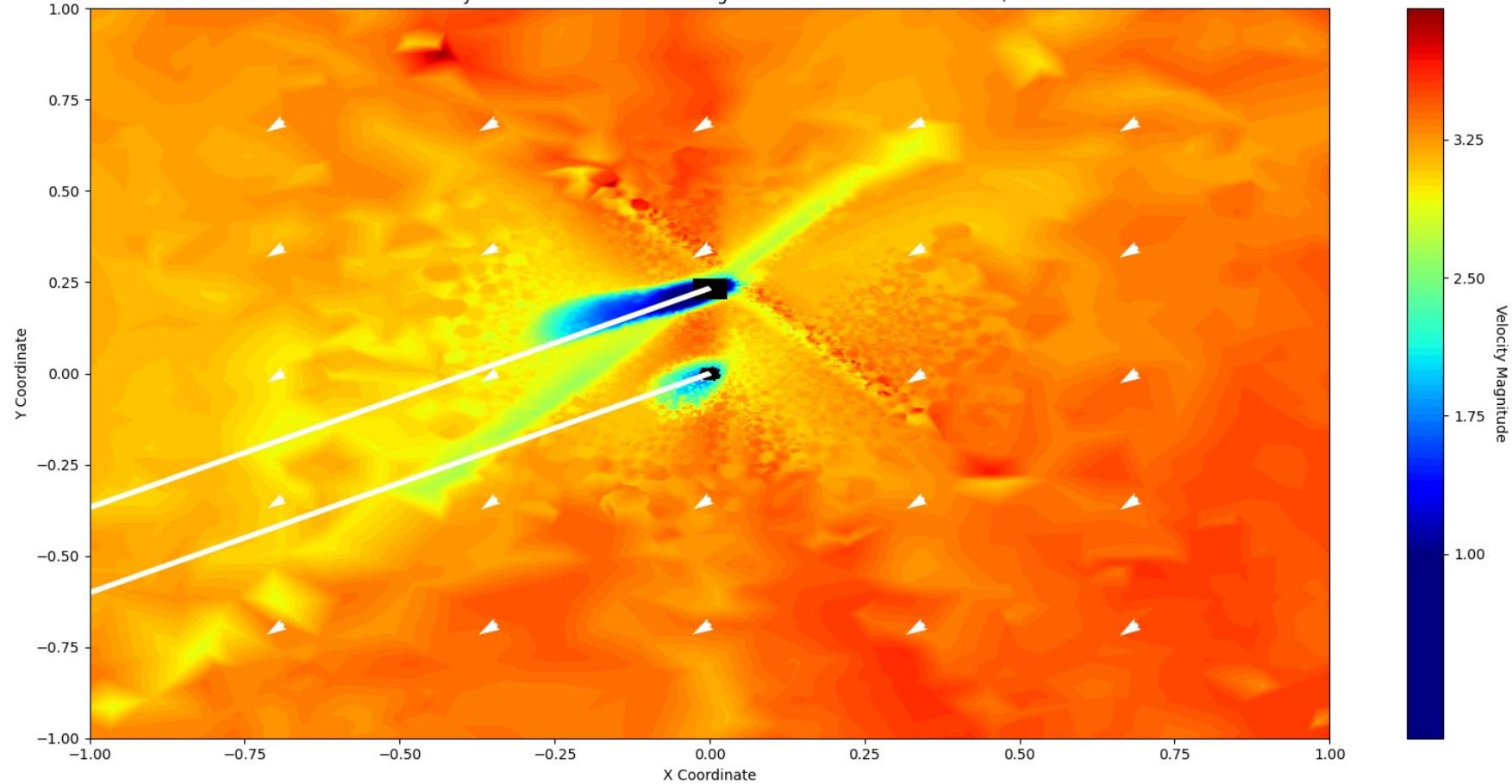
Total Velocity in the X-Y Plane for Wind Angle = 57 with a cut at Z = 0.17 +/- 0.02



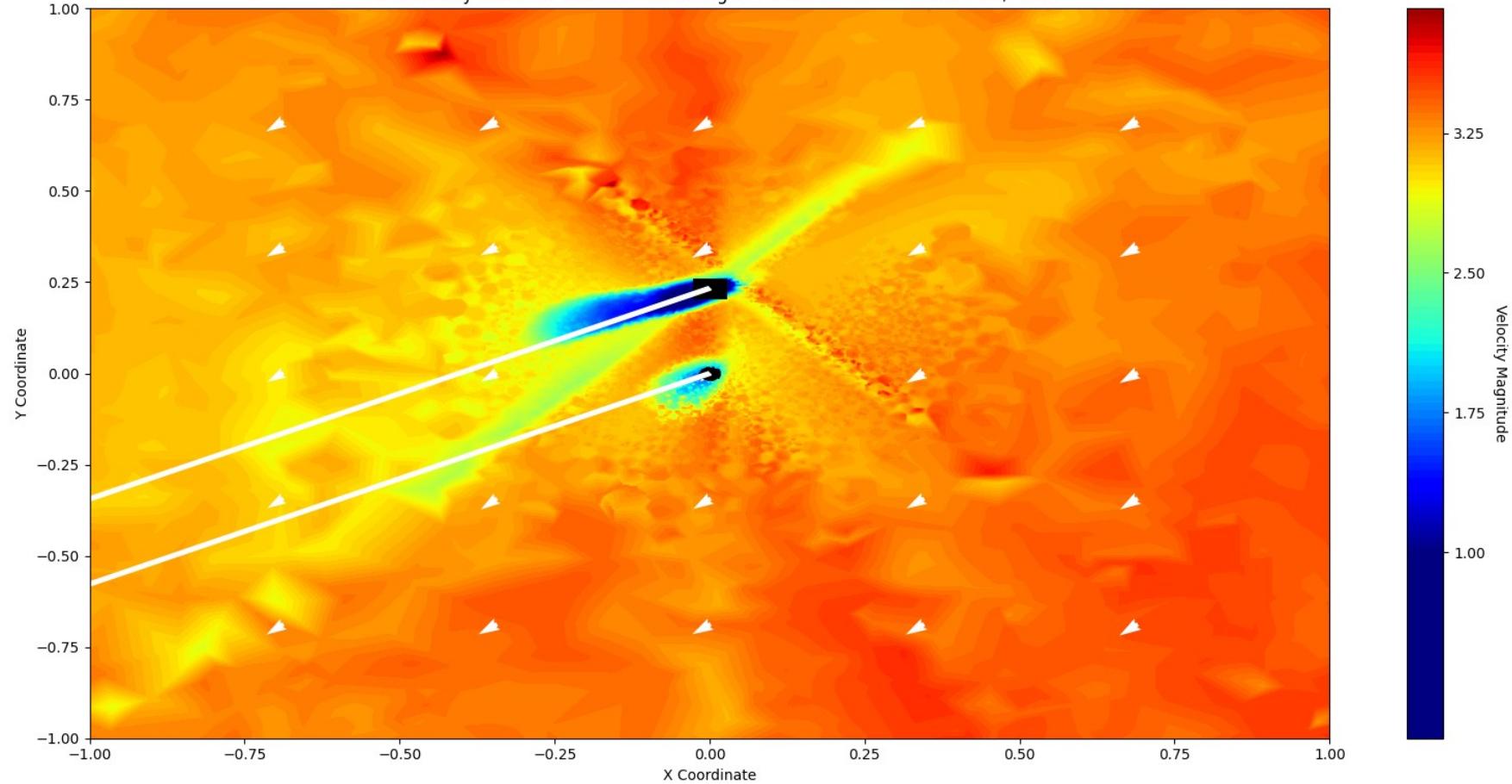
Total Velocity in the X-Y Plane for Wind Angle = 58 with a cut at Z = 0.17 +/- 0.02



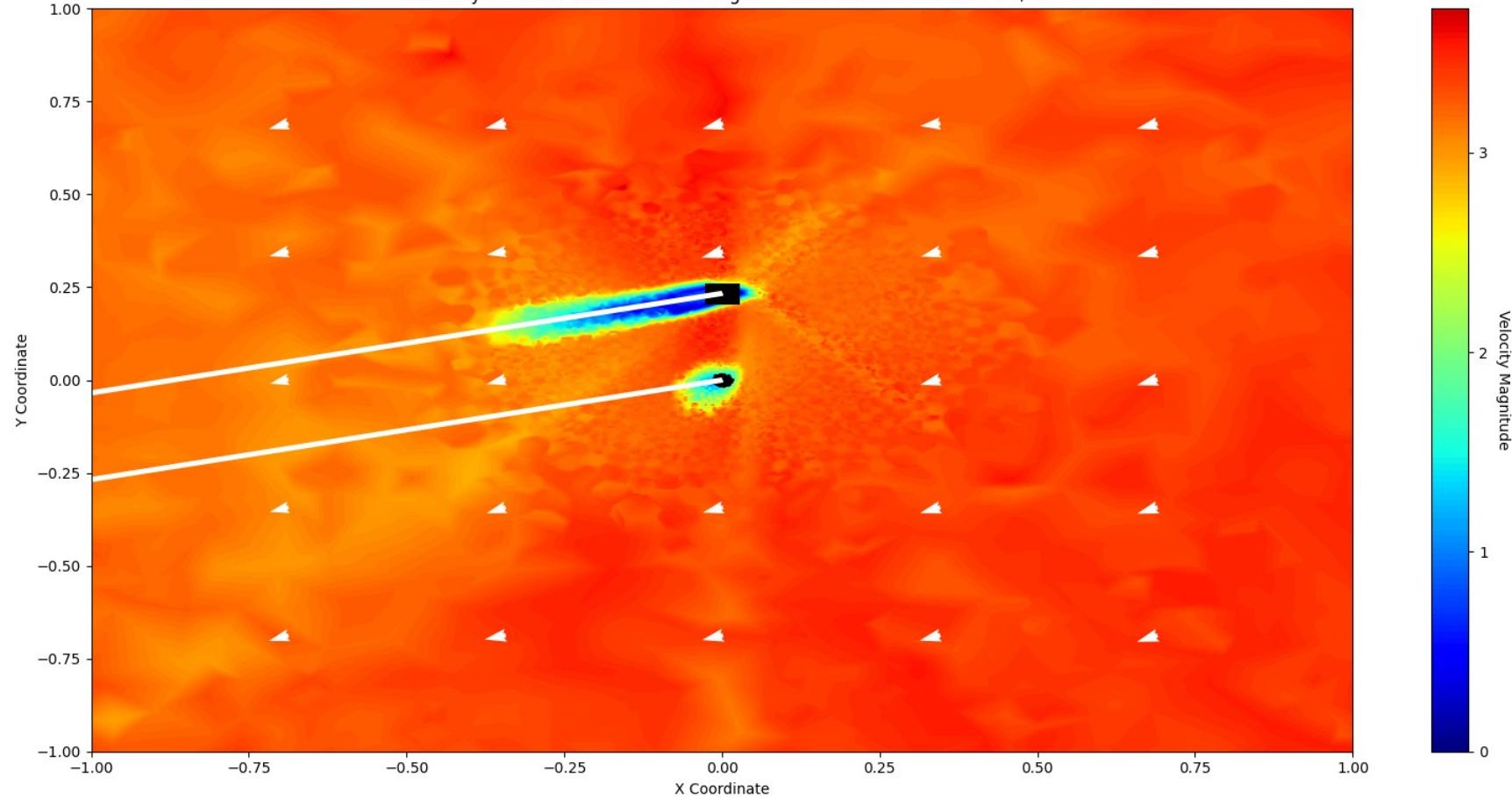
Total Velocity in the X-Y Plane for Wind Angle = 59 with a cut at Z = 0.17 +/- 0.02



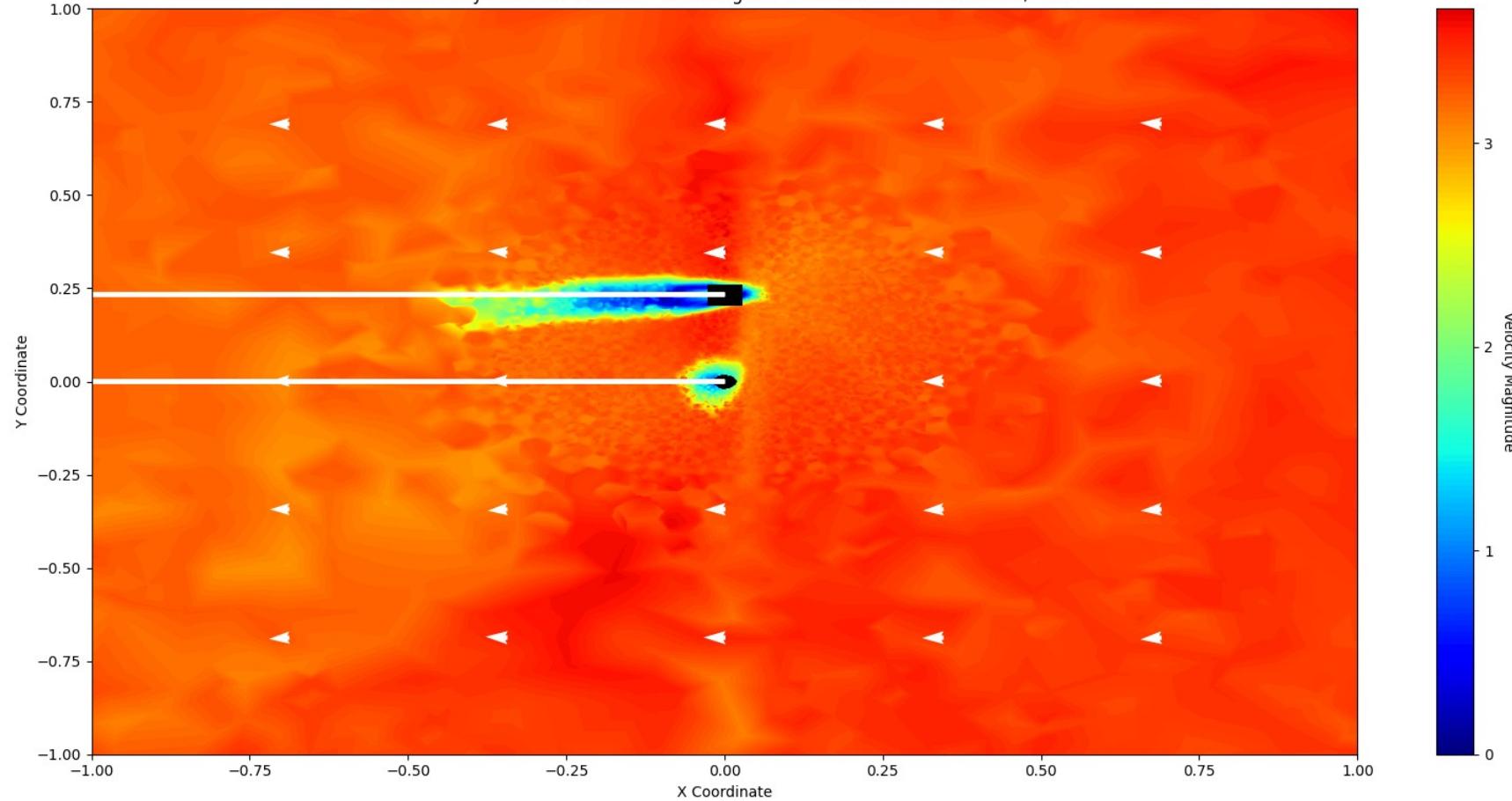
Total Velocity in the X-Y Plane for Wind Angle = 60 with a cut at Z = 0.17 +/- 0.02



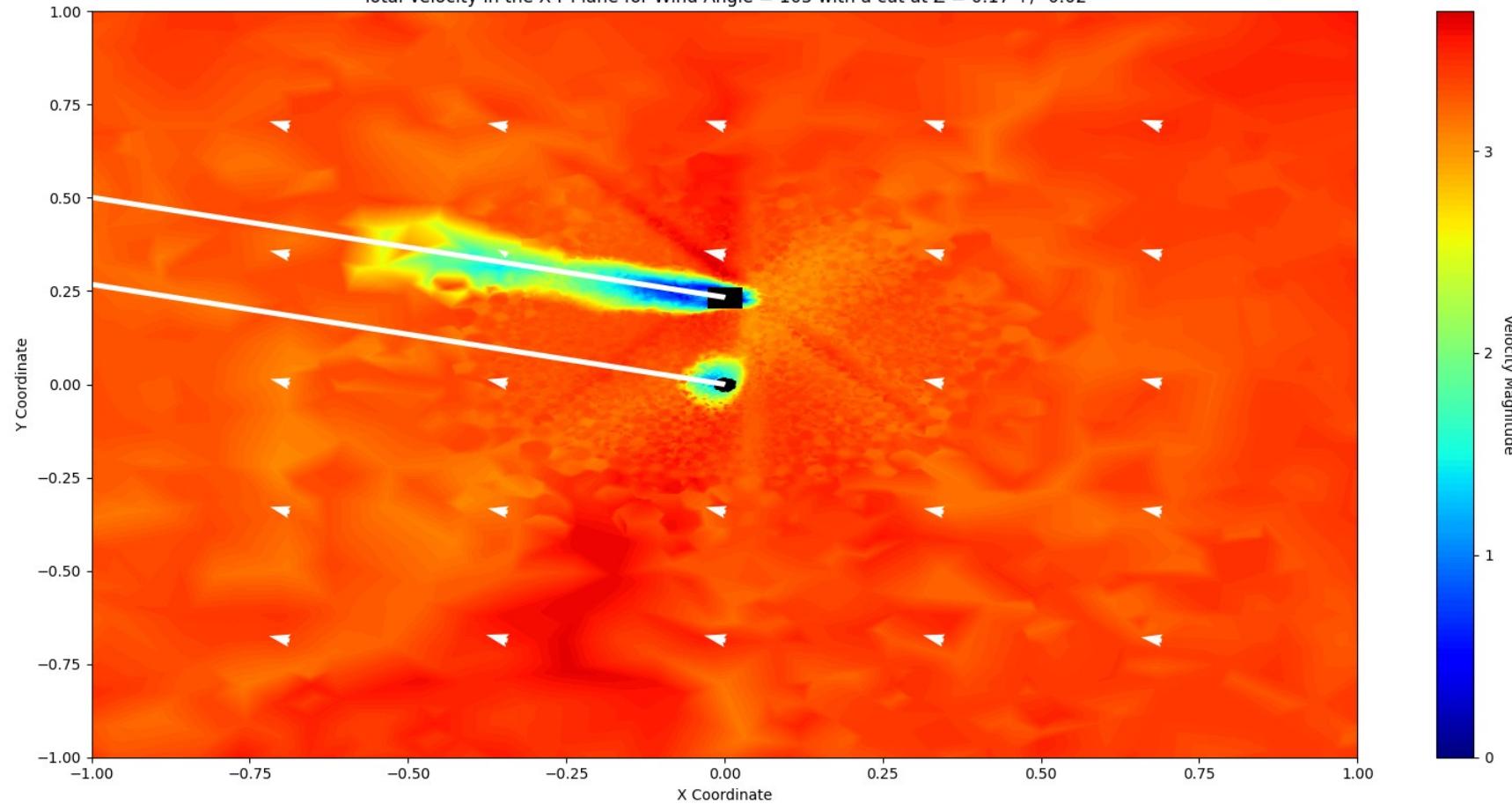
Total Velocity in the X-Y Plane for Wind Angle = 75 with a cut at Z = 0.17 +/- 0.02



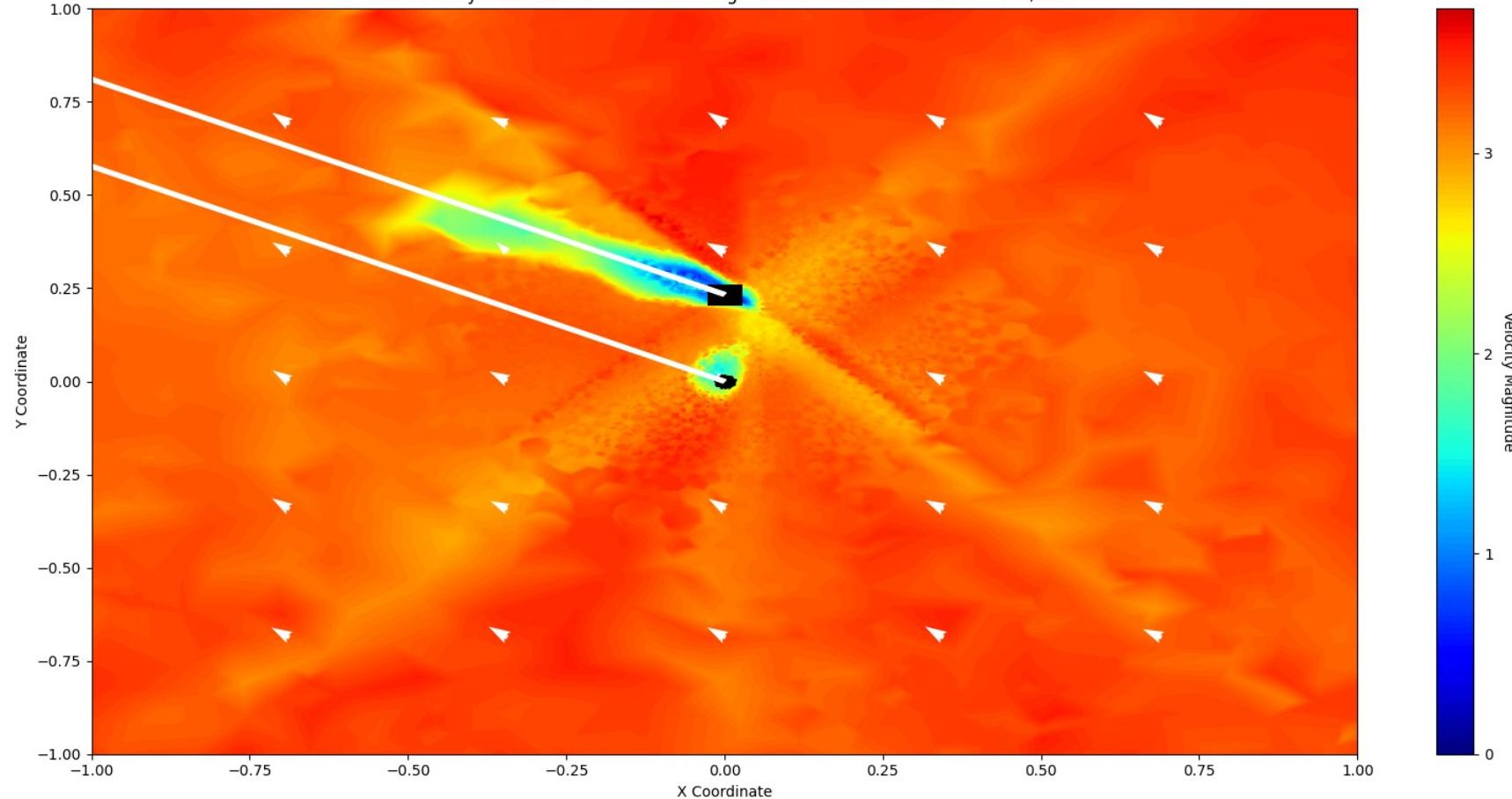
Total Velocity in the X-Y Plane for Wind Angle = 90 with a cut at Z = 0.17 +/- 0.02



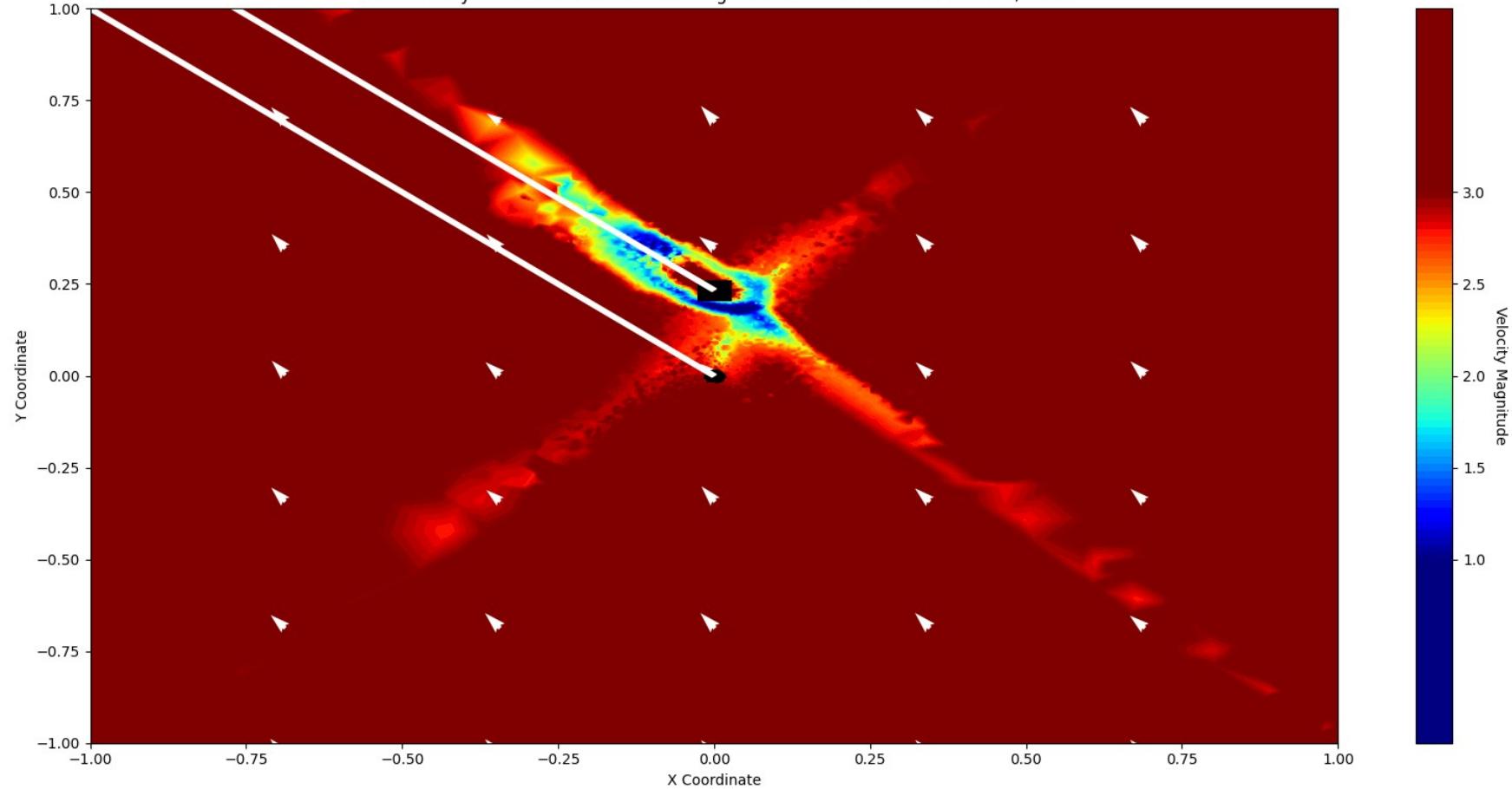
Total Velocity in the X-Y Plane for Wind Angle = 105 with a cut at Z = 0.17 +/- 0.02



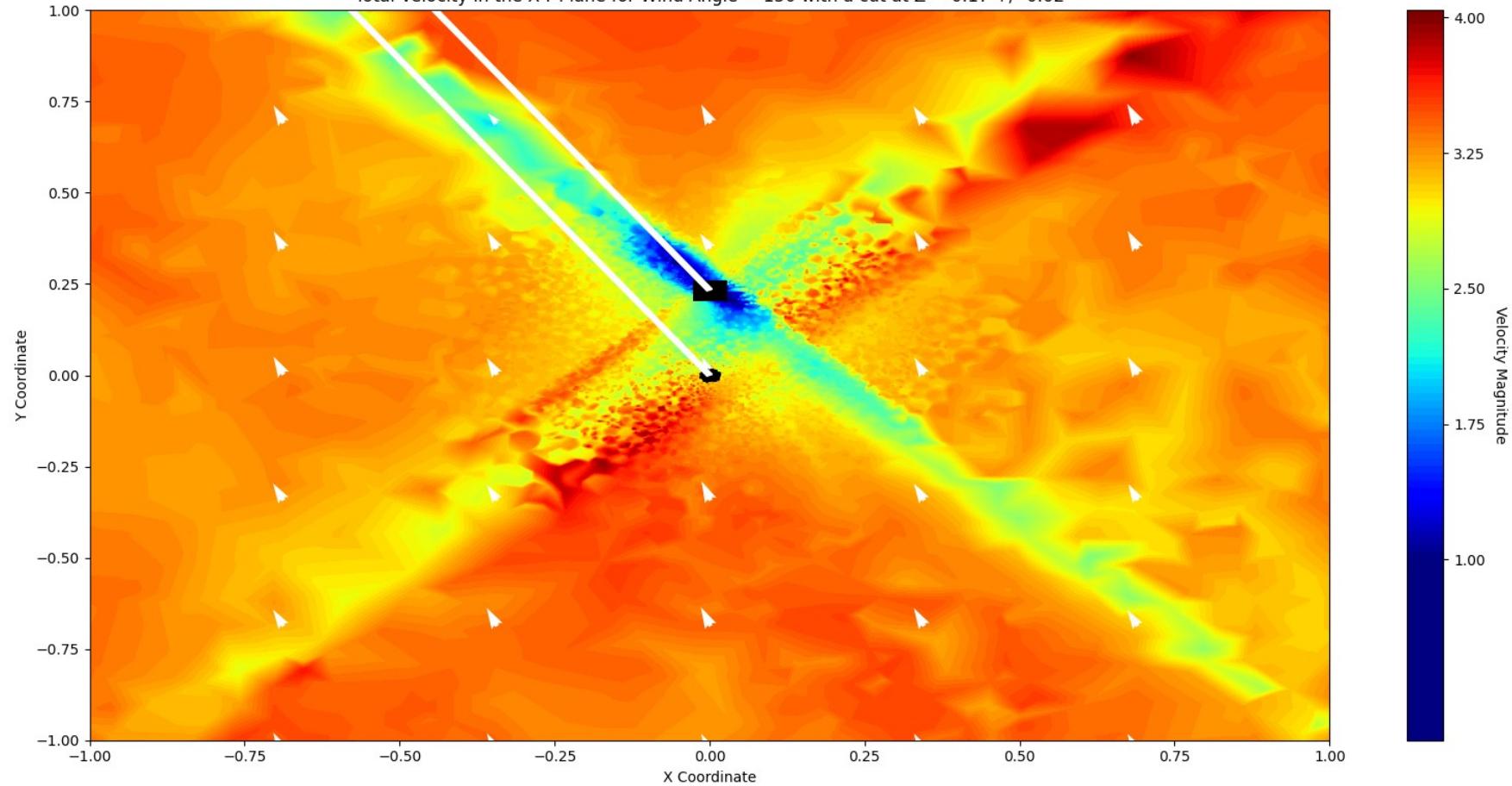
Total Velocity in the X-Y Plane for Wind Angle = 120 with a cut at Z = 0.17 +/- 0.02



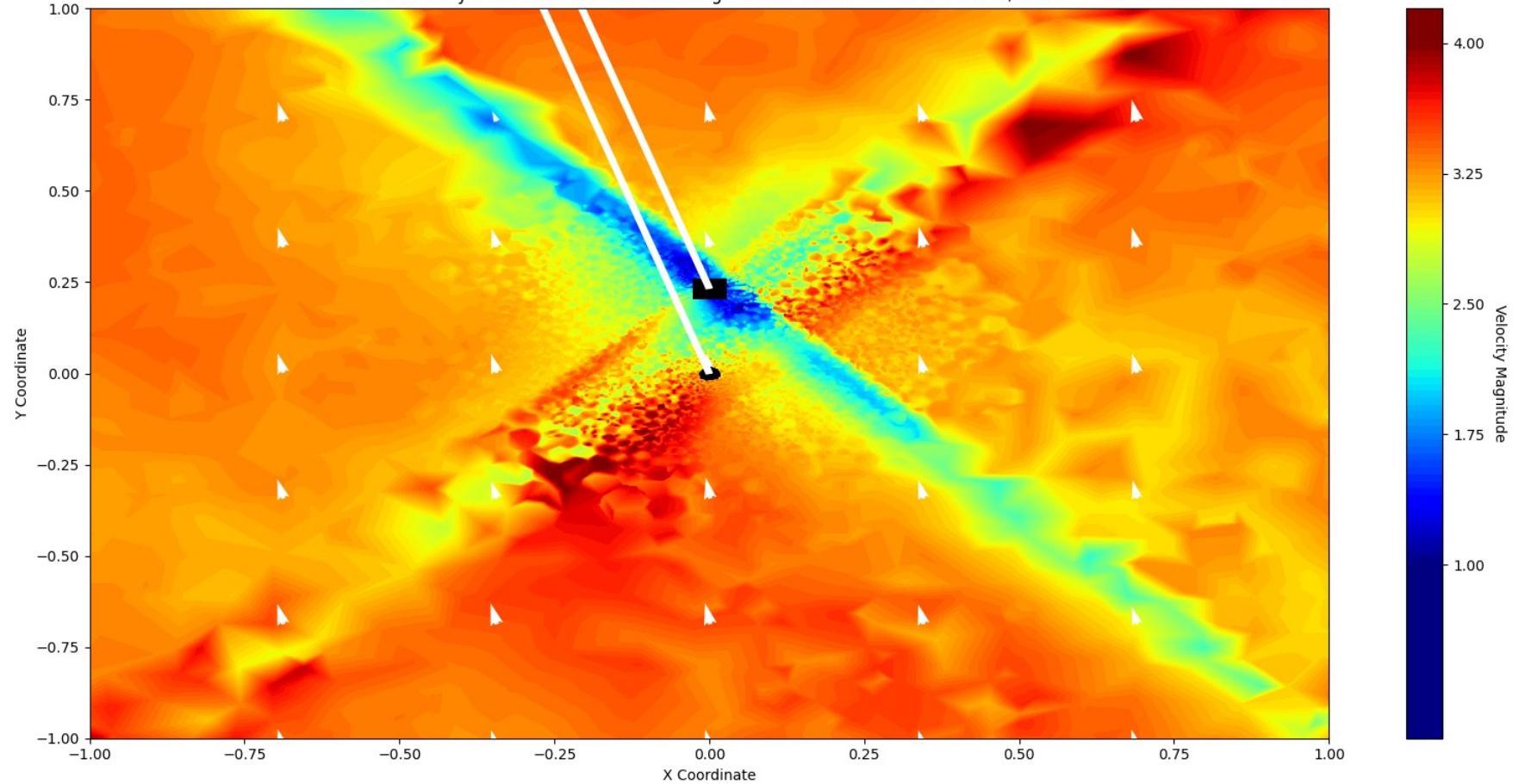
Total Velocity in the X-Y Plane for Wind Angle = 135 with a cut at Z = 0.17 +/- 0.02



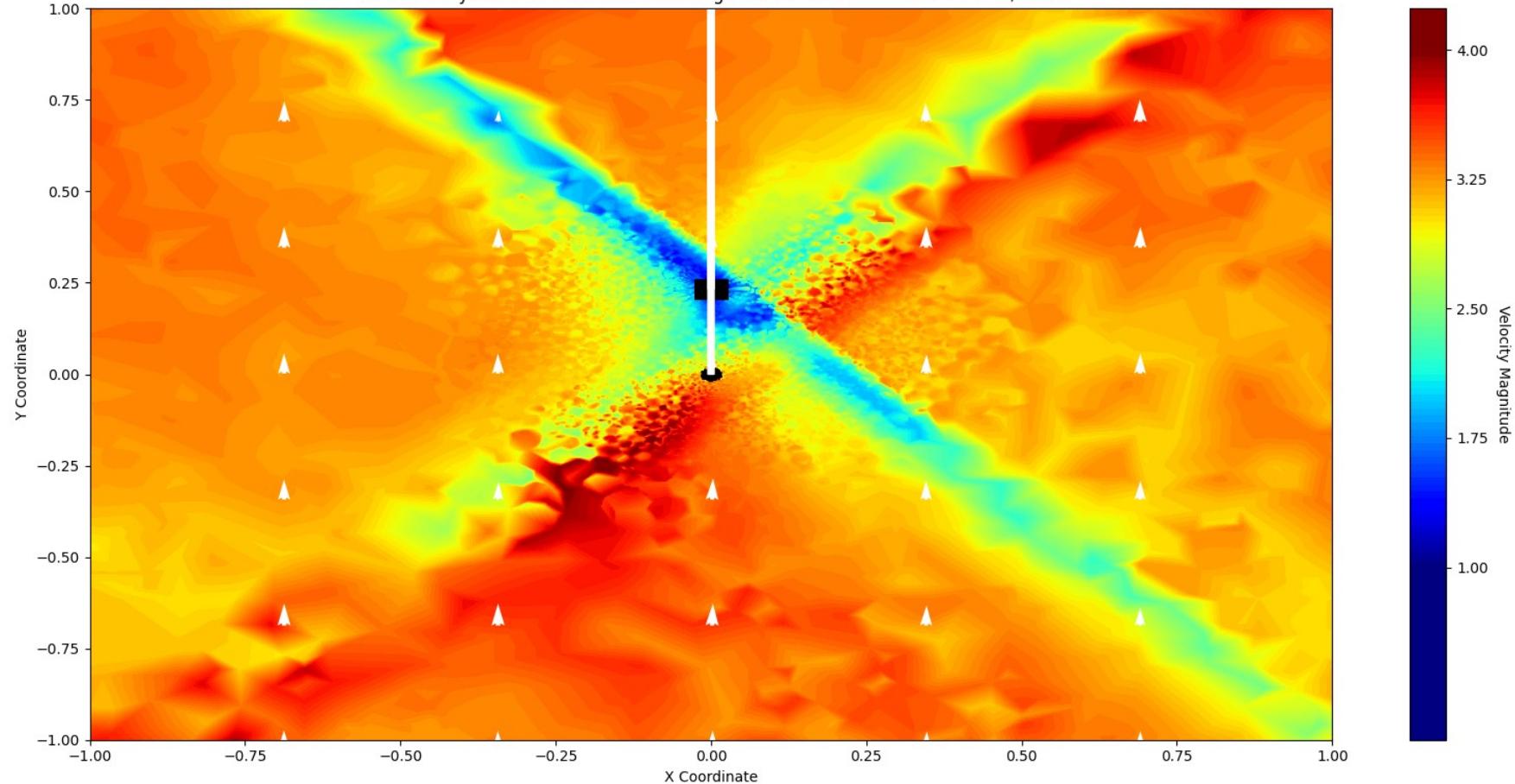
Total Velocity in the X-Y Plane for Wind Angle = 150 with a cut at Z = 0.17 +/- 0.02



Total Velocity in the X-Y Plane for Wind Angle = 165 with a cut at Z = 0.17 +/- 0.02



Total Velocity in the X-Y Plane for Wind Angle = 180 with a cut at Z = 0.17 +/- 0.02



Statistical Comparisons

Statistical Comparisons - MSE

Type	Data Loss (NC - 14505)	Data + No Slip (NC - 1030)	Data + No Slip + Inlet (NC - 2215)	Data + Cont + No Slip + Inlet (NC - 305)
Velocity:0	0.250057728211143	0.0532236924650972	0.180166510802504	0.897047555002864
Velocity:1	0.247255388675443	0.0572523441479038	0.189689449807947	0.295321045145586
Velocity:2	0.0014839236719385	0.0075613956141028 4	0.0126651486614695	0.0142119835311582

Statistical Comparisons - R2

Type	Data Loss (NC - 14505)	Data + No Slip (NC - 1030)	Data + No Slip + Inlet (NC - 2215)	Data + Cont + No Slip + Inlet (NC - 305)
Velocity:0	0.754659487654433	0.947780346275545	0.823232241674705	0.119874805241339
Velocity:1	0.759721760865162	0.944363224955807	0.815663281490145	0.713012439942471
Velocity:2	0.954639574806382	0.768864041595348	0.612853046764769	0.565569558590656

Some Next Steps

Optimise TPU Script

Why does adding in more physics/boundary conditions result in something worse?

La Defense?